Tooling Equipment Number

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Production Work in a Contract Shop

Manufacturing Methods Employed in the Plant of the Taft-Peirce Mfg. Co., Woonsocket, R. I., in Machining Automobile Parts—First of Two Articles

By FRED R. DANIELS

A CONTRACT or job shop is rarely equipped for handling large production jobs. Yet there are exceptions, and the present article deals with an instance where a contract shop has successfully solved the problems met with in quantity production. Many of the tools, jigs, and fixtures used in the manufacture of the Wills Sainte Claire eight-cylinder V-type automobile engine were made in the Taft-Peirce Mfg. Co.'s shop in Woonsocket, and in addition some thirty-five or more parts of this engine are being actually manufactured in this factory. Some of these parts include the valve follower assembly and shaft; camshaft drive pinion shaft bearing; fan assembly and shaft; distributor driven gear; intermediate shaft; piston-pin; and complete parts for the assembly of the camshaft drive shaft bearing retainer, oil-pump, oil relief valve, and connecting-rods. The present article deals with some of the more interesting operations employed in the manufacture of a number of the parts mentioned. Practically every finished dimension of these parts is held to close limits, which requires accurate manufacturing methods.

The parts of the valve follower assembly which involve the use of interesting equipment are the valve follower housing cover shown in Fig. 2, and the valve follower shown in the upper left corner of Fig. 3. These small forgings are assembled into the cover as shown at *A*, Fig. 5, four being used in the right-hand housing and four in the left. The forgings are first heat-treated, sand-blasted, and snagged to remove the scale on the sides of the hub, and then drilled and reamed on a Prentice drilling machine which carries a special multiple drill-head and an indexing fixture accommodating three pairs of forgings.

This machine is illustrated in Fig. 4, from which it will be seen that two followers *A* may be loaded at one station of the fixture while two other pairs are being drilled and reamed. It will be noted by referring to Fig. 3 that the reamed hole is held to a tolerance of 0.0005 inch. At every index movement of the fixture, two completely drilled and reamed forgings are removed. While the next two pairs of forgings are being machined, ample time is afforded the operator to reload and keep close watch on the condition of the holes by the frequent use of a plug gage.

The index device is released for revolving the turret of the fixture by the handle at the right of the loading station. This handle operates a rack and pinion, which withdraws the index-pin, and after it has been withdrawn it is snapped back ready to engage the next index-hole when the turret is revolved to the proper position. The work is located on the fixture by V-blocks that engage the hub of the work, and is secured in place by a wedge that is operated by a crank-handle.

The operation of rough- and finish-grinding cheek *A* of the forgings, Fig. 3, is performed on two Taft-Peirce cylindrical grinders, equipped with a special head and multiple grinding fixtures. One of these

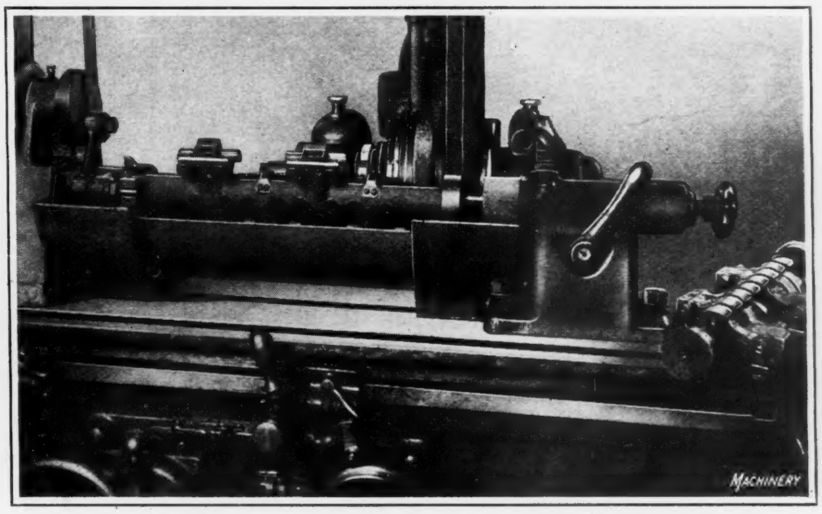

Fig. 1. Cylindrical Grinder with Special Equipment for grinding the Curved Surface of Valve Followers

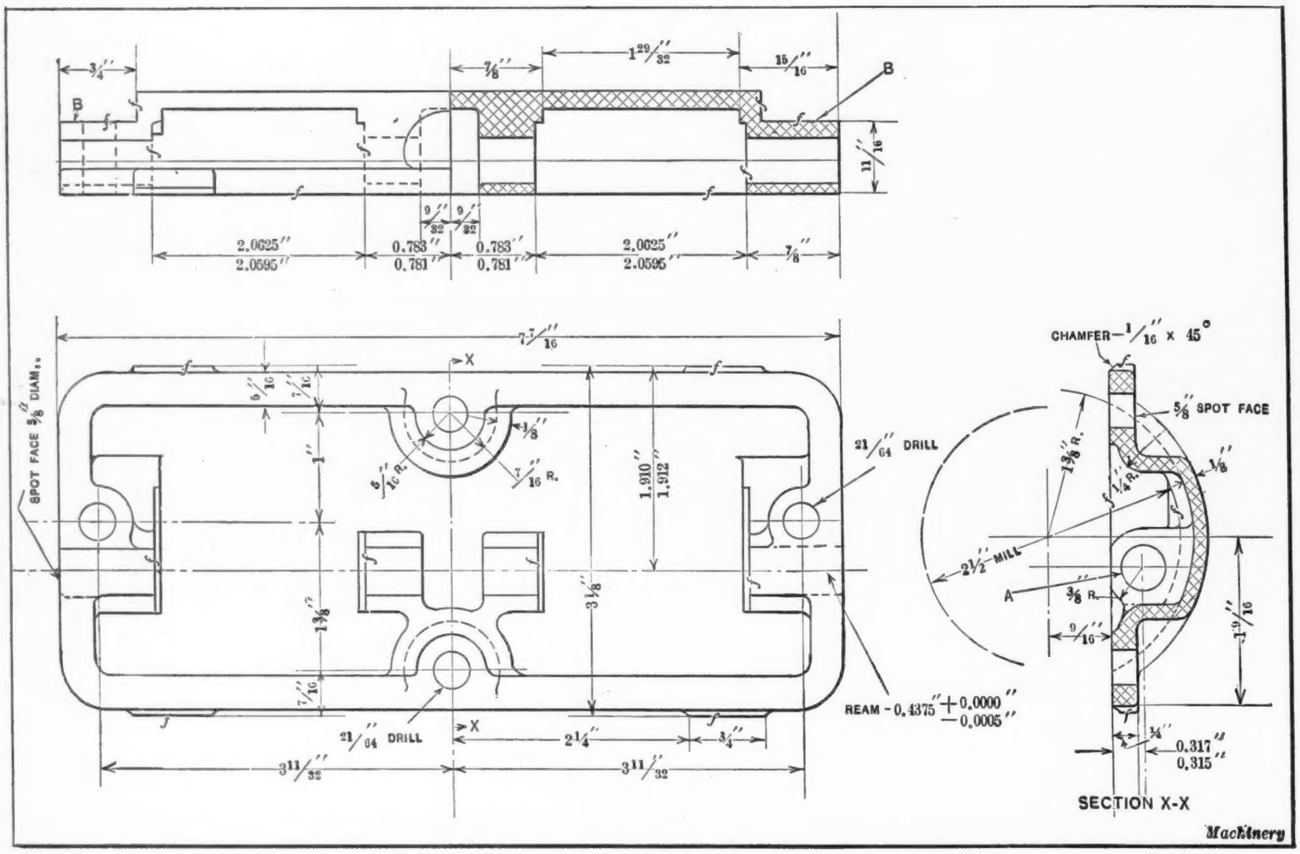

Fig. 2. Detailed Views of the Valve Follower Housing Cover

machines set up for the operation is shown in Fig. 1. The head transmits an oscillatory motion to the fixture and work; thus the machine practically performs the service of a radial grinder. The grinding fixture carries eight followers at a time in pairs, two machines and three fixtures being in use at once on this operation. A loaded fixture is shown on the table of the machine. As soon as one set of followers has been rough-ground, the fixture carrying the rough-ground work is transferred to the finish-grinding machine and replaced with another fixture. While the two machines are in operation the finished work is removed from the idle fixture and reloaded.

Fixture Used in Grinding Valve Follower

An assembled view of this special equipment is shown in Fig. 6, from which it will be seen that the spindle carries a

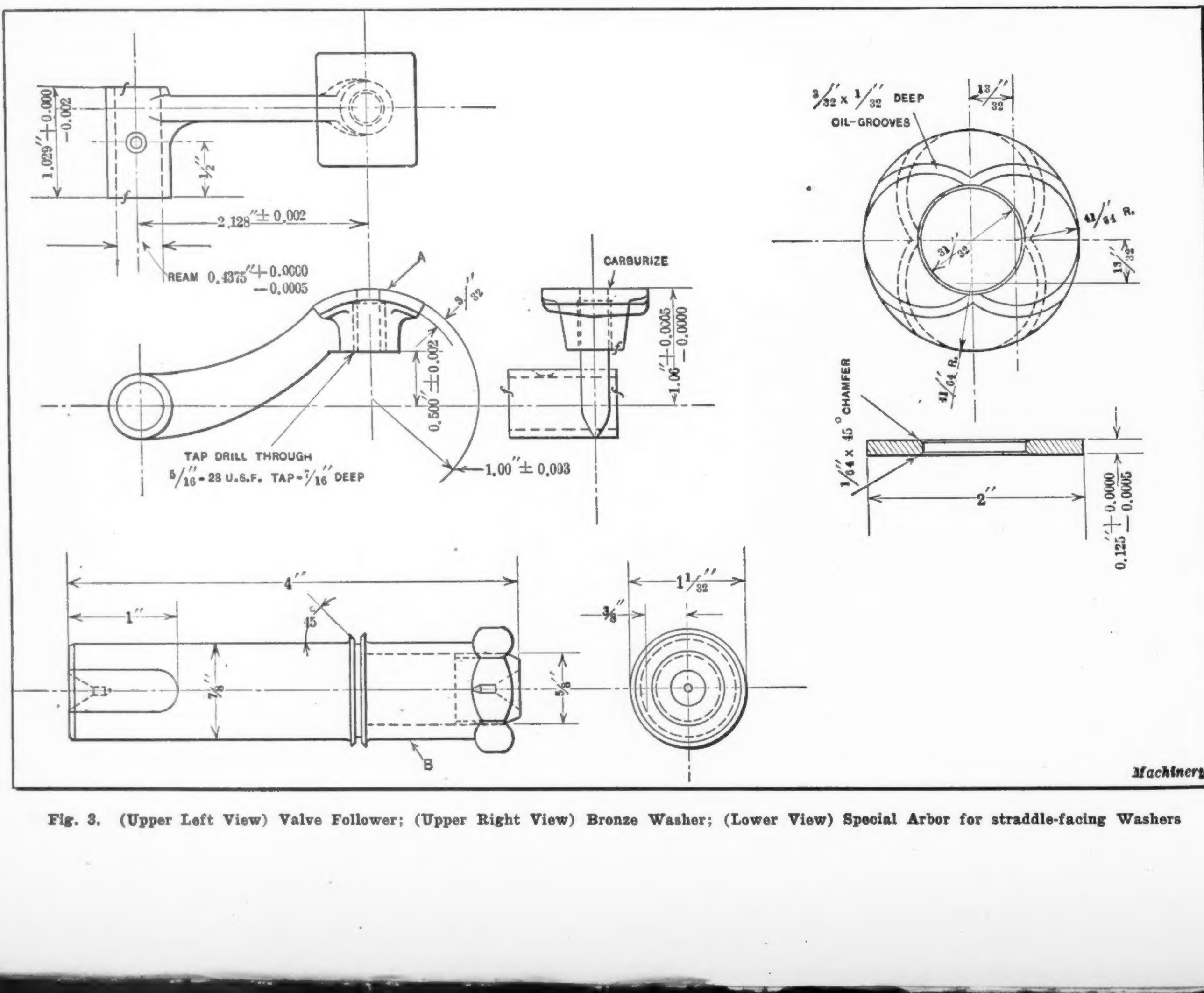

Fig. 3. (Upper Left View) Valve Follower; (Upper Right View) Bronze Washer; (Lower View) Special Arbor for straddle-facing Washers

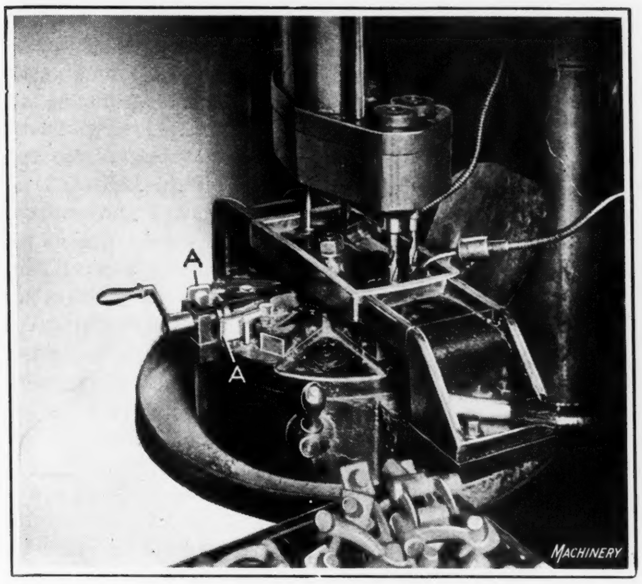

Fig. 4. Drilling Machine equipped with Multiple Head and Indexing Fixture for drilling and reaming Valve Followers

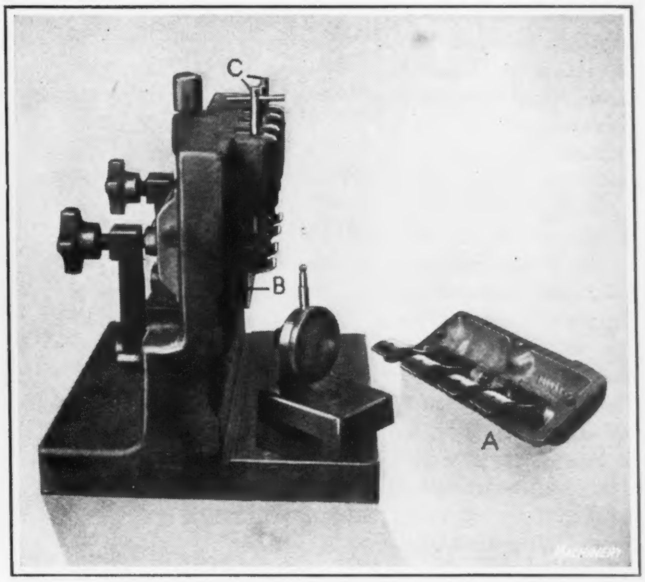

Fig. 5. Inspector's Gage and Test Blocks employed for gaging the Ground Cheek of Valve Followers

slotted driver *A* to which the crank-arm is attached in such a way that it can be adjusted to vary the arc of oscillation of the fixture. The body *B* has two projections on each side, in which a steel stud *C* is secured; the stud extends at both sides of the projection so that two followers may be carried on each stud. The end view shows the work *W* in broken outline in the position which the opposing followers occupy relative to the face of the grinding wheel when the loaded fixture is set up.

The head end of the fixture body has a cast ear *D*, so that when the fixture is placed between centers, a stud *E* will engage a slot in the ear to drive the fixture. Upon tightening a thumb-screw, the crank-arm transmits a rocking motion to the fixture. The work is seated against steel buttons carried in the body, and is held in this position by flat springs *F* which engage each pair of forgings close to the cheek. In loading the fixture, the operator simply snaps these springs over the work. The body of the fixture has steel female centers inserted at each end.

For the roughing operation a 36-L Norton wheel is used, and for finishing a 38-46 grade J wheel. A grinding wheel speed of 2500 revolutions per minute is employed which is equal to approximately 6000 feet surface speed per minute, and a feed of 0.0005 inch per oscillation. It may be mentioned incidentally that the same equipment is used for grinding the forgings to remove the copper-plating from the cheeks before the forgings are carburized on these surfaces.

Valve Follower Assembly

The camshaft housing valve follower cover in which the follower forgings are assembled is an aluminum casting. The central hole *A*, Fig. 2, which carries the stud for the followers must be accurately line-reamed and must have a uniform diameter in all four bearings within a tolerance of 0.0005 inch. This 7/16-inch hole is line-reamed on a Prentice lathe carrying a special long line-reamer with a universal-jointed driver which is held in the lathe chuck. The set-up of this job is illustrated in Fig. 7, which also shows the fixture used to hold the work while the holes are being reamed.

The work rests on four hardened steel buttons located so as to coincide with the centers of bosses cast on the inside of the aluminum covers. It is held back against two ground blocks at the rear of the fixture by means of a floating clamp *A* which seats evenly on the unfinished surface of the casting when the knob *B* is tightened. The cover of the fixture also has an equalizing clamp *C* carrying a hardened and ground button at each end, engaging the flat surfaces *B* (see Fig. 2), at each end of the casting. The fixture itself is clamped in

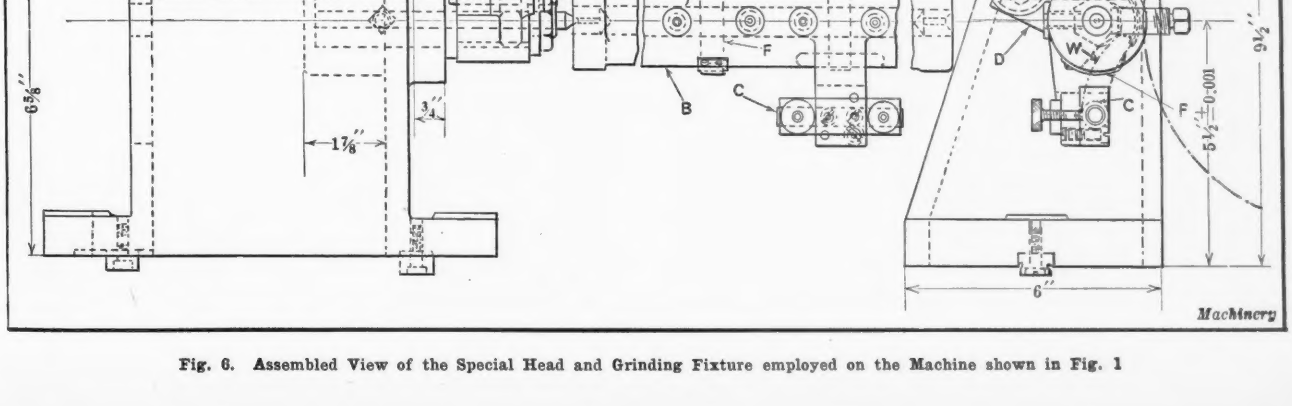

Fig. 6. Assembled View of the Special Head and Grinding Fixture employed on the Machine shown in Fig. 1

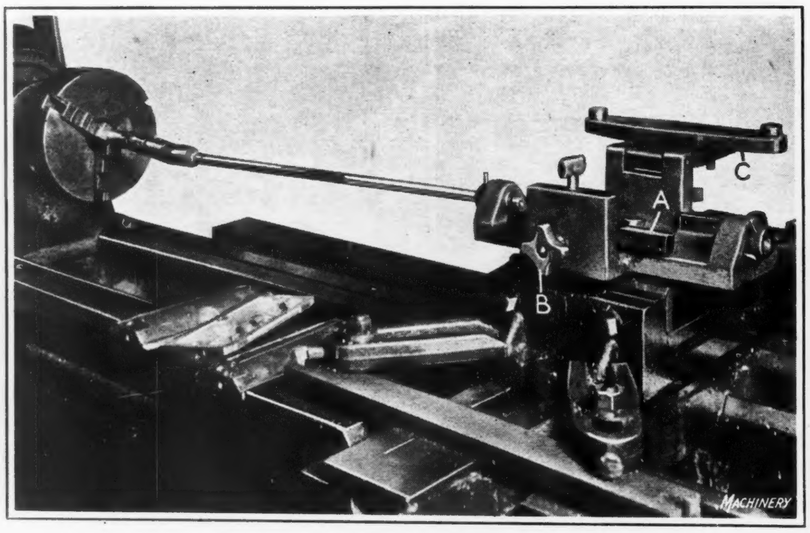

Fig. 7. Lathe set up for line-reaming Valve Follower Covers

a milling vise which, in turn, is clamped to the bed of the lathe. The reamer operates at 180 revolutions per minute, and the feed is 0.005 inch per revolution of the spindle.

The gaging equipment for inspecting the ground cheeks of the assembled followers relative to the finished face of the aluminum cover, as well as the alignment, is illustrated in Fig. 5, which shows the assembled unit clamped to the upright part of the fixture on one side, with the followers extending through and resting on a hardened steel parallel *B*, which is set into the opposite side of the fixture. Four spring pins *C* hold the followers against the parallel, while a test block with a dial indicator is employed to gage the accuracy of the ground surfaces on the followers.

Camshaft Drive Pinion Floating Washer

The camshaft drive pinion floating washer, shown at the right in Fig. 3, is machined from a cast bronze cylinder from which nineteen washers are made. The cutting apart of these bronze washers is illustrated in Fig. 8, which is a view of a Lodge & Shipley lathe looking toward the faceplate, and showing the multiple tooling set-up which is employed in this operation. The parting tools are set evenly in a special tool-block by means of a backing plate which is adjusted by the two screws shown at *A*. The casting is grooved to a depth which will bring the diameter within the grooves to 0.985 inch. This is slightly greater than the reamed diameter of the axial hole in the casting so that the washers can be readily broken apart. For grooving, a work speed of 50 feet per minute is used, with a hand feed.

It will be seen from Fig. 3 that there are circular oil-grooves 1/32 inch deep in both sides of this bronze washer. The machine and fixture used for cutting these grooves is illustrated in Fig. 9. The difficulty of holding these thin flat pieces so they would not become distorted made necessary the provision of special means for performing the oil-grooving operation. A heavy fixture is used for holding the washers during the milling of the grooves; to the base of this fixture is attached an upright bracket, which furnishes a rigid bearing for the cutter-arbor. This arbor has a driving lug which fits into a slot in the end of the hollow end-mill used to cut the grooves. One of these mills is shown on the table of the drilling machine. The mill can enter the arbor bearing when the machine spindle is raised, thus giving ready access to the work when loading and unloading the fixture.

The upper part of the fixture which carries the work may be slid transversely so as to bring the center of the spindle 13/32 inch either side of the center to agree with the location of the grooves in the work, as shown in Fig. 3. This movement of the fixture is effected by hand, the weight being sufficient to make the use of a locking device unnecessary. The cam-lever shown at the side of the fixture raises a center post to bind the work from underneath against flanges extending on each side, under which the work is located. This eliminates all possibility of distortion, and holds the washers perfectly flat during the grooving operation. A similar grooving operation is performed on both sides of the work using the same equipment. A Henry & Wright drilling machine is used for this work. It has been found advantageous, owing to the toughness of the material from which these washers are made, to heat them to between 650 and 700 degrees F. before any further machine work is performed. Formerly this was not done, and some difficulty was experienced in finish-facing the washers to within the required limits.

The washers are straddle-faced to a thickness of 0.128 or 0.129 inch, using diamond facing tools, and are then ground to the finished thickness indicated in Fig. 3, where it will be seen that a tolerance of 0.0005 inch is allowed. Considerable difficulty was experienced at first in holding the washers

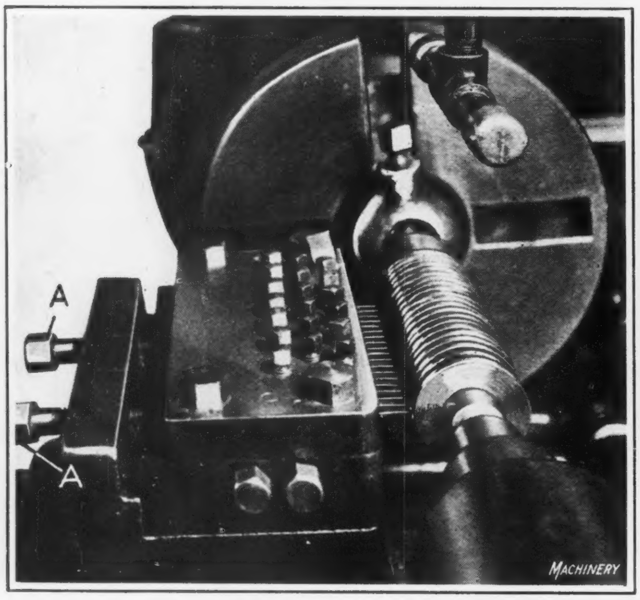

Fig. 8. Lathe with Multiple Tool-block, set up for cutting Bronze Washers from a Casting

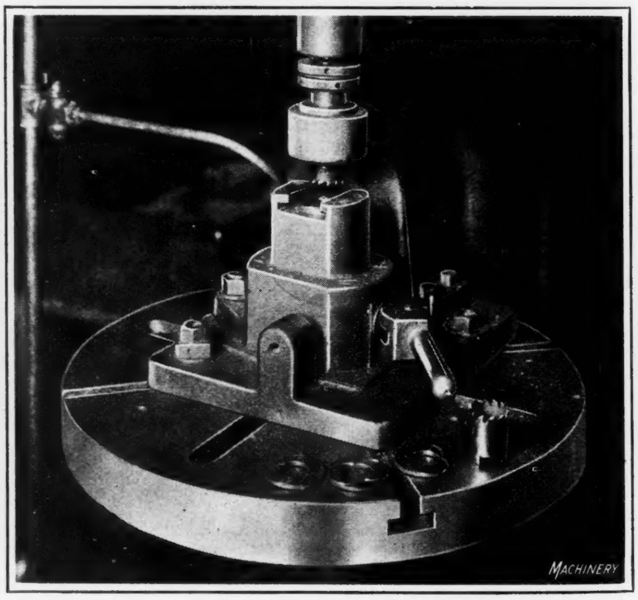

Fig. 9. Drilling Machine and Fixture used in cutting Oil-grooves in Bronze Washers

while straddle-facing them to thickness. For this reason, it was found desirable to chamfer both sides of the central hole, and to use a hardened tool-steel arbor, such as shown in the lower part of Fig. 3, to hold the work. This arbor has a 45-degree center and a sleeve *B* with a similar angular end, so that the washers can be mounted squarely between the shoulder on the arbor and the sleeve by means of the chamfered hole. A diamond tool is especially suitable for machining bronze, particularly where the work must be held within close limits. A hand-feed is employed and a work speed of 80 feet per minute.

The concluding installment of this article, which will appear in May MACHINERY, will describe operations on the camshaft drive shaft bearing retainer, the motor fan, and the intermediate and fan shafts.

* * *

SET-UP INSTRUCTIONS FOR BROWN & SHARPE AUTOMATICS

By SAMUEL R. GERBER
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The importance of adhering strictly to detailed instructions for setting up automatic screw machines can readily be seen. If the set-up man does not see to it that he has all the necessary tools for the job before he starts setting up a machine, he may find himself well on the way before he discovers that a tool is missing. The set-up man can avoid this difficulty by adhering strictly to the rule of returning all tools to the tool-crib immediately after taking a job off the machine. If all tools, cams, and accessories are placed in a box and returned to the tool-crib where they are kept until they are needed again, there will be no need to search for tools the next time the job is started. It should be the duty of the man in the tool-crib to inspect the tools carefully before he puts them away. If he finds any tool that needs repairing, it should be attended to before the tools are put away on the shelves; if he finds any that are worn out or broken, he should immediately put in a requisition for replacements, so that they will be on hand when needed again.

It is also of vital importance that the set-up man set the machine to operate at the correct feeds and speeds. For this purpose he should be furnished with an instruction card which contains all the necessary information. Without such information the feeds and speeds and lay-out depend entirely on the memory of the set-up man. If the feeds, speeds, and job lay-out are noted on a card at the time when the machine is operating satisfactorily considerable trouble will be obviated on future set-ups.

List of Setting-up Operations

The following list of operations for setting up Brown & Sharpe automatic screw machines and the detailed explanation of these operations, if strictly adhered to, will, no doubt, greatly reduce the lost time in the department and consequently reduce costs, which, after all is the ultimate aim.

1. Obtain tools, instruction card, and drawing from tool-crib. Check all tools with tool list to make sure that none are missing. If any are missing, report to the man in charge of the crib and if he cannot furnish the required tool immediately, return all tools to him and start another job.

2. Tear down old job and return tools to crib. Remove gears, cams, and tools; clean and place in box. First remove and clean chuck. Then remove feed-finger from feed-tube and substitute new one. Finally, return tools to crib.

3. Put in chuck and feed-finger. Use pin-wrench for tightening up chuck-head.

4. Put on cams and gears and shift belts. Follow carefully the directions on set-up card and see that the belts are set to give proper speeds.

5. Grind tools. It is important to provide proper rake and clearance angles.

6. Place tools in turret and cross-slides and set them properly. Follow instructions furnished on set-up card, measuring the distance from the turret for all turret tools and setting cross-slide tools in proper relative positions.

7. Set trip-dogs. To set trip-dogs for turret tools, turn the handwheel until the cam-roll is on the high point of the cam lobe; then move the turret trip-dog in position under the trip-lever. Turn the handwheel until the cam-roll is on the high point of the next cam lobe and set the trip-dog as before. Continue this until all trip-dogs for the turret are set. To set the trip-dog for the chuck, turn the handwheel until the cam-roll just reaches the top of the stop-lobe on the cam; then move the trip-dog to position under the trip-lever. To set the trip-dog for the spindle, turn the handwheel until the cam-roll is on the high point of the cam lobe just preceding the cam lobe for threading; then move the trip-dog to position under the trip-lever. The second spindle trip-dog should be set where the cam-roll reaches the "dwell" of the cam lobe for threading. When both overhead and machine speeds are changed, avoid tripping simultaneously.

8. Put stock in chuck and adjust. The jaws should be adjusted so that the chuck can be locked with a snap by means of the hand-lever.

9. Make final adjustments. Adjust tools to bring part to fit gage. Set gage-stop first to obtain the proper length of piece. Feed stock to the stop, mark with the cut-off tool, measure the distance between the end of stock and the cut-off mark, checking this distance by means of the length gage. Finally adjust the feed length. The following precautions are necessary in making final adjustments: (A) Set the forming and cutting-off tools accurately before setting the turret tools; (B) test the thread body diameter before running on the threading die; (C) test length of piece before drilling or threading; and (D) test the diameter of holes before reaming.

10. Report to foreman. The foreman should always pass on the quality of the work before it proceeds further.

Importance of Following a Predetermined Sequence in Setting up the Machine

The order of operations in the list given is of the utmost importance for the successful setting up of the job in minimum time. For instance, the third step "Put in chuck and feed-finger" must be done before the sixth step "Place tools in turret and cross-slides, etc.," and the fifth step "Grind tools" must surely be done before the tools are set in place. Nevertheless, it is surprising how frequently these operations are done in the reverse order, which means repeating certain steps.

The seventh step "Set trip-dogs" must be done before the eighth step "Put stock in chuck and adjust." If the stock is put in the chuck before the trip-dogs are set, as is usually the case, it invariably follows that either a drill or the cut-off breaks. This means that the set-up man must remove the stock and proceed as he should have in the first place.

After the trip-dogs are set and the stock supplied, the set-up man may proceed to make the required piece, which can generally be done with few additional adjustments. It may require time and patience to train a set-up man to follow instructions in setting up an automatic screw machine, but any machine shop foreman will readily agree that it is worth while to train the set-up man, especially if he realizes that he can save time in the department by employing some such simple instruction methods.

* * *

Individual motor drive in the textile industry has been applied successfully for the first time to the revolving flat cotton card, an installation having been made at the plant of the Mason Tire & Rubber Co., of Kent, Ohio. Push-button control is employed, which provides for easy starting of the cylinders and spindles and permits adjusting the speed to suit conditions. The drive is equipped with a reversing motor switch.

Selling Machine Tools by Demonstration

By a Machine Tool Sales Manager

EXPERIENCED salesmen state that there are two classes of minds—those most easily impressed by what they see, and those most easily influenced by what they hear. Machine tool salesmen will probably agree that their customers respond more quickly to what they see than to what they hear; but still it is necessary both to explain and to demonstrate. The salesman has a fund of information about the machines he sells. This is his sales talk—his talking points for the ear of the prospect. In addition, he has something to show, to be conveyed through the eye. This is commonly called the demonstration.

The Use of Catalogues, Blueprints, and Photographs

In the simplest form of demonstration, the salesman uses catalogues, photographs, and blueprints. He seldom goes very far with his talking points without resorting to catalogues and other trade literature. He appeals simultaneously both to the ear and to the eye of the prospect.

It is the ambition of salesmen in some lines to become such fluent talkers that their prospects will listen to them spellbound, developing an eagerness to buy all that is offered for sale. It is doubtful if any machine tool salesman ever reached that goal, and if he did, it would not be of great value; for machine tool selling is an unemotional matter-of-fact business, and it is questionable if the most accomplished spellbinders from other fields of selling would have any great success with machine tools. Nevertheless, there is great value in being able to set forth selling arguments logically and forcefully; but an even greater appeal can be made through the eye, and more sales have been made by men who can clearly demonstrate the value of what they have to sell than by those who merely talk about the good features.

Some salesmen do not make the most of catalogues as a selling aid. Any machine tool manufacturer can tell of letter after letter received from possible customers, asking questions about points that are illustrated and explained in the catalogue, even though the salesman has called upon them recently. The salesman has overlooked some good demonstration material. Many salesmen also receive blueprints and photographs from the manufacturer, and submit them to their prospects without first becoming familiar with the recommendations made. They neglect to take advantage of the possibility of demonstrating to the prospect in terms of the prospect's problems.

The Importance of Complete Explanations of Methods

The neglect to fully explain lay-outs, drawings, and blueprints works an injustice not only to the manufacturer but also to the prospect. Recently an automobile manufacturer sent out blueprints to several machine tool builders. He received a number of proposals, and finally purchased a machine from Black & White. A bid had also been made on equipment by Smith Co. whose sales manager later happened to visit the automobile plant and saw Black & White's machine on the job. The production was much less than Smith had quoted. He asked why the other machine had been chosen. The buyer frankly told him that Smith's proposition had not been thoroughly studied. "It was really an oversight," he admitted, but added "Your salesman was also to blame. Your method of handling the job is somewhat unusual, and I did not understand at the time. The blueprints were left with me without explanation, and in the rush I did not study them thoroughly. Black & White's proposition, on the other hand, was presented to me so clearly that it seemed to me at the time to be the best we could hope to do. Now that we have this equipment, we cannot afford to take it out."

In this case the salesman lost out possibly because he did not himself fully understand the manufacturer's production plans, and left the blueprints for the buyer to study instead of using them as a means to demonstrate the superiority of his machine and method. No doubt he told the buyer repeatedly what the machine would do, but neglected to explain *how* it was done.

Demonstration of Machines

The use of catalogues and blueprints is not as effective as a demonstration of the machine itself. In some cases it is almost impossible to sell without an actual demonstration of a machine in operation. But there are great difficulties connected with demonstrations of machine tools.

An example of the physical demonstration of a difficult subject was recently met with in the practice of a bronze bearing manufacturer whose claims of superiority are based on the physical construction of his metal. This manufacturer had only a limited success when he depended upon printed or verbal statements. Then he supplied his salesmen with a microscope and fractures of his and other bearing bronzes. By thus demonstrating his metal in comparison with other materials, he not only increased his business but also received the benefit of publicity through his prospective customers telling their friends about the unique demonstration.

The practice of taking prospects to visit installations in nearby shops in order to demonstrate machine tools is very effective, but there are several objections to be noted. Frequently new machines are being introduced, and in that case other installations are not always available or conveniently reached. Sometimes a machine in use does not show up in as satisfactory a way as regards finish. The particular job on the machine at the time may not demonstrate it at its best, and it is always somewhat of an imposition on even a good friend to disturb his shop with visitors and temporarily hold up production; last, and most important, the salesman depends upon someone else to play what is usually the last card in his hand.

Demonstrations in Show-rooms

The show-room of a machinery house is seldom put to its maximum use. As a display place of machine tools it accomplishes only one of its possibilities. It augments the catalogue demonstration by showing the tool itself, so that the buyer can note its proportions and finish, and can move a lever or two or a handwheel here and there; but it would be still more effective if the machine were actually running. In European machine tool sales-rooms it is the usual practice to have one machine of every type under belt, and the salesmen are trained so that they can step up to the machines and operate them in a way that brings out the various features. This practice is worthy of thought on the part of those who would derive the maximum value from their show-room floor space.

Let us take a leaf from the book of the seller of phonographs. The chances of selling a phonograph by means of a catalogue are remote. The chances of selling by a mere display of the cabinet are small. But the playing of a record on the machine exhibits the service that the salesman really

tries to sell. It is service that is sold in machine tools just as much as in phonographs.

In making a first-class demonstration of any article, it is highly important that the demonstration be in line with the normal use of the product. A salesman for the manufacturer of small tools used to carry with him a milling cutter as a sample of the firm's product. It is impossible to make a quick demonstration of the normal use of a milling cutter, but this salesman thought that he could demonstrate the abuse that his cutter would stand by throwing it on the floor. All went well with his demonstration until once when the cutter came in contact with a concrete floor. After he had exclaimed "Just see the abuse our cutters will stand," he sent the cutter to meet the hard concrete. The cutter broke into several pieces.

The writer has often heard machine tool salesmen argue that an exhibit that is not under belt at a convention is a waste of space; yet only a small percentage of the visitors at a convention are buyers, and under the excitement of the convention they are least susceptible to impressions. On the other hand, a running exhibit on a machinery dealers' floor is a perpetual exhibit to which only interested parties come, and they can concentrate upon the one item of the machine that they wish to buy.

The Introduction of New Machinery and Tools

There is every indication that many improvements in machinery and tools will be introduced by machine tool builders in the near future. Totally new and different tools will be brought out, but even in the mechanical field the buyers are notoriously slow in taking up new ideas. They are invariably skeptical, and equipment for machine shops is the object of more careful scrutiny than many other classes of products. The buyers of machine tools will not seek new equipment. The machine tool salesman must seek the buyer. There is still plenty of room for improvement in the demonstration and methods of selling machine tools. It is those that give most careful thought to effective demonstration who will enjoy the greatest success in selling.

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FORM TOOL FOR GRIDLEY AUTOMATICS

By JOE V. ROMIG

In turning formed work on Gridley four-spindle automatics, it is customary to rough-turn with one tool and finish-form with another. A double-deck type of tool-holder such as the one shown at *A*, Fig. 1, is used on the rear or forming slide. The forming and sizing tool *F* and its holder *B*, shown mounted on the double-deck holder *A*, were devel-

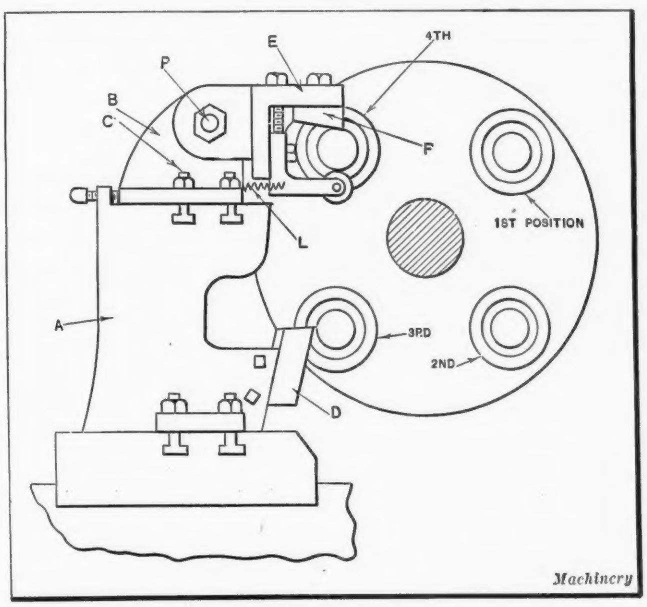


Fig. 1. Double-deck Tool-holder used on Gridley Automatics

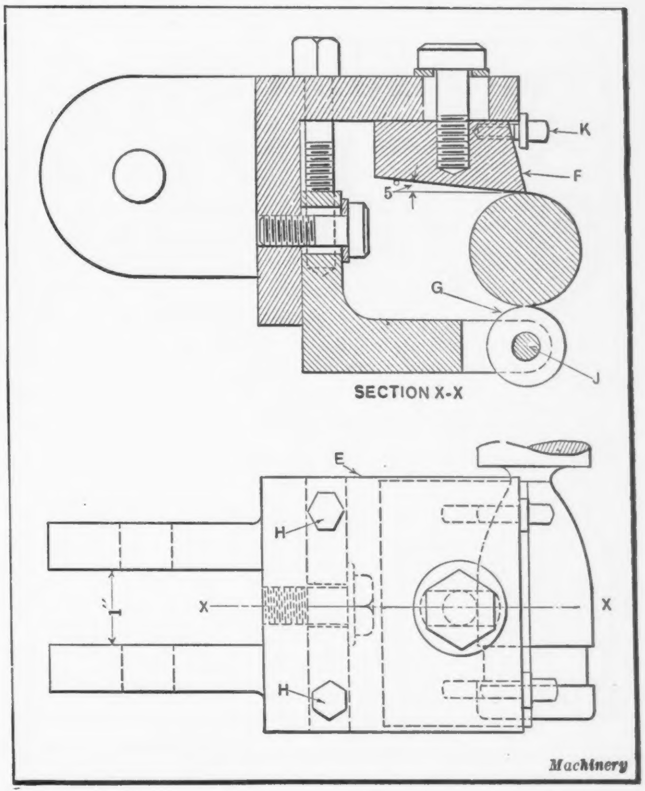


Fig. 2. Forming Tool used in Holder shown in Fig. 1

oped for use on work requiring a fine finish and a high degree of accuracy. The holder *B* is of inverted T-shape, and is clamped to the top face of holder *A* by bolts *C*. Slots are provided for these bolts which permit the tool to be adjusted so that it will be properly aligned with the lower tool *D*.

On the vertical section of holder *B* is pivoted the tool-carrying head *E*, which is also shown in Fig. 2. This tool-head is made of an accurately machined casting. The tools used in this holder are made with a bottom clearance of from 5 to 8 degrees and a lip angle which varies from 0 to 7 degrees according to the hardness of the material to be machined. It will be noted that the tool *F* shown in the illustration has a bottom clearance angle of 5 degrees. This tool passes over the top of the work, the latter being held to size by means of the roller *G*. This roller is mounted on an adjustable slide and is clamped to the inner face of the holder *E* as shown. Two elevating screws *H* are used to adjust and hold the roller square with the tool. On work having more than one diameter it is necessary that the roller be built up of two pieces of different diameters, each roller running loosely on the roller-pin *J*.

On tapered work also two rollers must be used, as any slippage on the work would mar the finished surface. By pivoting the whole head as shown, a self-adjustable feature is introduced, which works satisfactorily. The pivoted bolt *P*, Fig. 1, should be drawn up tight enough to hold the head erect by the friction of the clamping faces. The tool *F* is drilled and tapped on its front face for the two small screws *K*, which are used to adjust and hold the tool square with its holder as indicated in Fig. 2. A newly sharpened tool sometimes has a tendency to chatter, but this can be overcome by drawing a fine-grained oilstone across the edge.

Besides turning and forming the work accurately to size, the tool also has a burnishing action, which produces a very fine finish. The writer has found it advisable to insert a spring *L*, Fig. 1, between the base and the swinging head. This spring is made just strong enough to lift the head slightly. This will bring the roller into engagement with the work and permit the tool to be drawn downward as the slide feeds inward, thus resulting in a clean shearing cut. From 0.005 to 0.010 inch is sufficient allowance for a finishing cut. This tool operates equally well on straight, curved, or tapered work. It was first used in making one-pounder shells.

Standardization of Jig and Fixture Design

THE use of standardized parts in the design of jigs and fixtures is intended primarily to avoid unnecessary repetitions in the designing department and to reduce the cost of designing jigs and fixtures as well as the time required for making them. When certain features or details adapted to standardization have been found to be satisfactory, the advantage of using duplicate designs whenever practicable is evident, since such uniformity in the construction of details not only reduces the costs but also insures the continued use of parts that have been tested out in actual practice.

How Many Parts Should be Standardized?

The number or variety of parts which may be standardized to advantage in connection with jig and fixture design varies in different plants, and depends in a general way upon the uniformity of the work. Where there is great diversity in shapes and sizes of the parts requiring jigs or fixtures, standardization is largely confined to such details as handles, bushings, stop-pins, adjusting screws, clamping straps, latches, eyebolts, binder levers, and certain other small parts of a minor nature. If too many parts are standardized, especially large parts which necessarily control to some extent the design of a jig or fixture, there is sometimes a tendency to sacrifice the design or arrangement in order to utilize a standard part. In such cases, the standard is a detriment rather than an advantage.

In connection with the standardization of parts either for jigs, fixtures, or gaging devices, it is advisable to utilize as far as possible all universally adopted standards and commercial parts, such as machine screws, cap-screws, washers, taper pins, or other parts which may be much cheaper to buy than to make in relatively small lots.

Standardization of the Larger Parts

In determining whether or not it will pay to standardize the larger and more important details, such as plates, bases, indexing devices, clamping mechanisms, etc., the probable extent to which such parts or details can be utilized is naturally the factor to consider. In this connection past experience in whatever plant the jigs and fixtures are intended

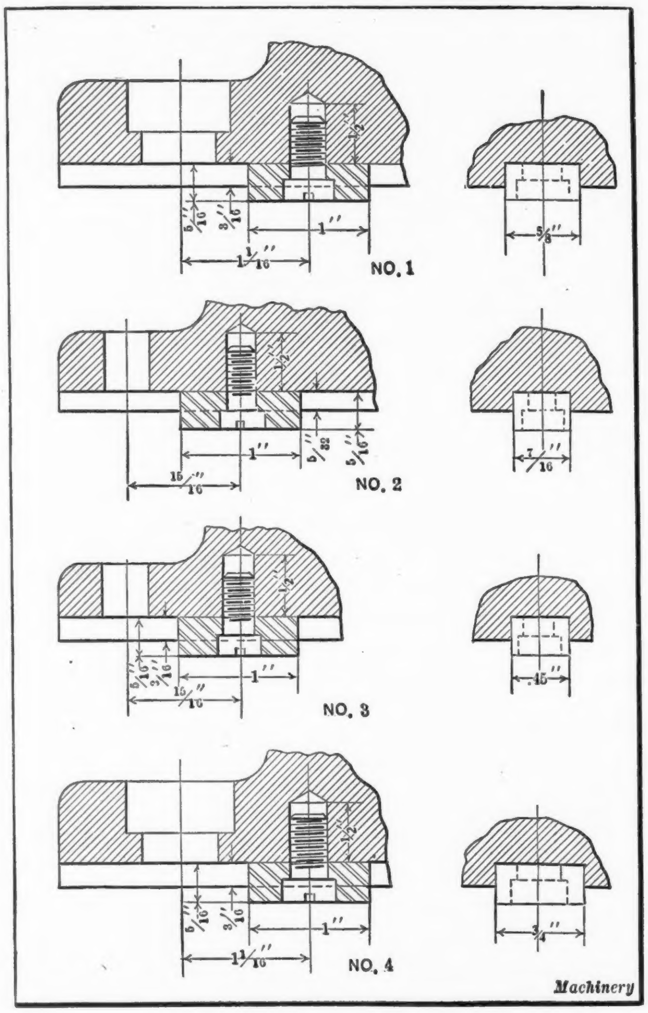


Fig. 2. Four Sizes of Standard Fixture Keys

for serves as a reliable guide in determining to what extent certain parts are likely to be used, and also the advisability of having in stock parts made up in advance. These stock parts, which should be kept on hand in amounts depending upon the probable number required under ordinary conditions, frequently make it possible to design and construct jigs and fixtures in a relatively short time.

In the designing department of the Pratt & Whitney Co., Hartford, Conn., the parts for jigs, fixtures, and gaging devices have been standardized as far as practicable, although in jig and fixture work, standardization is confined chiefly to the minor details, owing to the extremely wide range of work handled in the various departments and the necessity of designing jigs and fixtures which differ greatly, not only in size but also in arrangement. The following examples do not cover all the standardized parts, but they illustrate in a general way the kinds of parts that can be standardized to advantage. The dimensions are given whenever there is a range of sizes, for the convenience of those desiring to adopt similar standards.

Shoulder Screws

Fig. 1 illustrates six sizes of shoulder screws with body diameters varying from 3/8 to 1 inch. These screws are used as pivots for latches and certain kinds of clamping blocks or plates which require a swinging movement, as when inserting or removing work, but still remain permanently attached to the body of the jig or fixture. The section lines

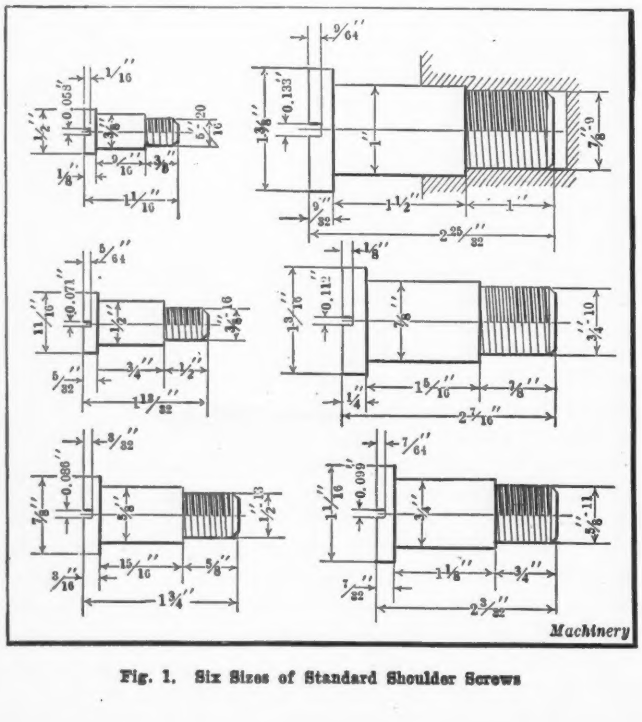
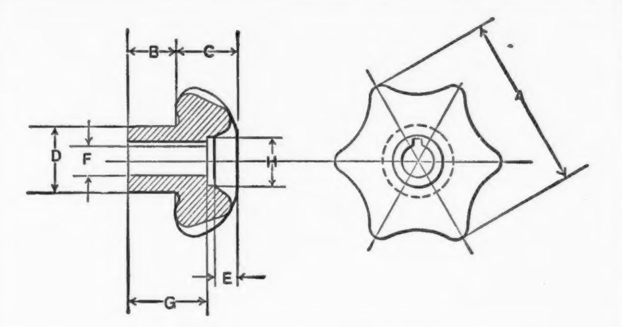


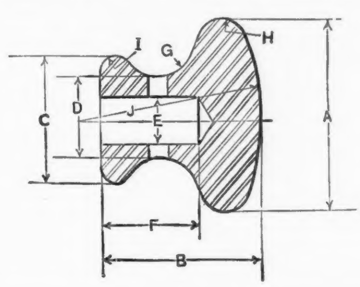
Fig. 1. Six Sizes of Standard Shoulder Screws

around the largest screw illustrated indicate how they are fitted in place. It will be noted that the body of the screw enters a counterbored recess for some distance, thus giving the screw a rigid support against lateral thrusts. These

TABLE 1. CAST-IRON AND STEEL KNOBS



A	B	C	D	E	F	G	H	Keyway Width	Keyway Depth
2 3/4	13/16	11/16	7/8	3/8	3/8	1 1/8	1/2	3/32	3/64
3 1/4	1	7/8	7/8	7/16	1/2	1 3/8	3/4	1/8	1/32



A	B	C	D	E	F	G	H	I	J	Pin Length
1 1/4	7/8	7/8	9/16	5/16	5/8	3/16	1/8	1/16	1 5/16	5/8
1 1/2	1 1/4	1	5/8	3/8	3/4	9/32	3/16	3/32	1 5/16	11/16
1 3/4	1 1/2	1 1/8	11/16	7/16	7/8	3/8	1/4	3/32	1 3/4	3/4
2	1 3/4	1 5/16	3/4	1/2	1	7/16	9/32	3/32	2	13/16

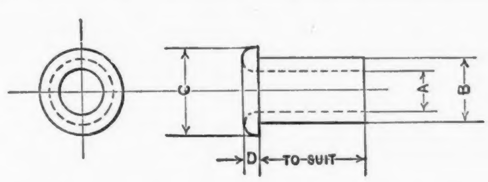
Machinery

screws are made of cold-rolled steel, casehardened. The heads should have a free fit when they enter counterbored recesses.

Fixture Keys—Standard Knobs

Four sizes of standard fixture keys are illustrated in Fig. 2. These are used for aligning a jig or fixture body with the machine by engaging a slot in the machine table. A tongue is sometimes formed directly on the body of the fixture by planing, but a removable key is generally considered

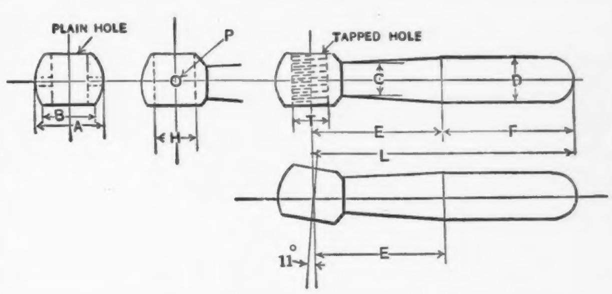
TABLE 2. STANDARD SHOULDER DRILL BUSHINGS



A	B	C	D	A	B	C	D
1/16	3/16	3/8	3/32	9/16	13/16	1 1/8	1/8
1/8	5/16	1/2	3/32	5/8	7/8	1 1/4	1/8
3/16	3/8	9/16	3/32	11/16	15/16	1 3/8	1/8
1/4	7/16	5/8	3/32	3/4	1 1/16	1 9/16	5/32
5/16	1/2	11/16	3/32	13/16	1 1/8	1 5/8	5/32
3/8	9/16	3/4	3/32	7/8	1 1/4	1 7/8	3/16
7/16	5/8	13/16	3/32	15/16	1 5/16	1 15/32	3/16
1/2	11/16	7/8	3/32	1	1 3/8	2	3/16

Machinery

TABLE 3. STANDARD BINDER HANDLES



Dimensions, Inches							Plain Hole		Tapped Hole	
A	B	C	D	E	F	L	H	P*	T	Th'ds per In.
13/16	5/8	5/16	1/2	1 3/8	1 1/2	2 7/8	3/8	2	3/8	16
1	3/4	7/16	11/16	1 5/8	2	3 5/8	7/16	3	7/16	14
1 1/8	13/16	1/2	13/16	1 7/8	2 5/16	4 3/16	1/2	4	1/2 9/16	13 12
1 3/8	7/8	9/16	15/16	2 1/8	2 5/8	4 3/4	9/16	5	1/2 9/16 5/8	13 12 11
1 1/2	1 1/8	5/8	1 1/16	2 5/8	3 1/8	5 3/4	5/8	6	5/8 11/16	11 11
1 3/4	1 1/8	11/16	1 1/8	3 1/2	3 7/8	7 3/8	9/16†	5†	9/16† 3/4	12† 10
2	1 1/4	3/4	1 3/16	4 1/8	4 3/8	8 1/2			5/8† 7/8	11† 9

Machinery

*Numbers in column P represent Nos. of taper pin drill used when assembling.
†Binder handles with hole or tap at pin angle.

preferable. These keys are all of the same thickness and length, but the widths vary.

Two forms of knobs are illustrated in connection with Table 1. The upper section of the table covers two sizes of cast-iron knobs which are keyed to the shaft. The steel knobs listed in the lower section are made in four different sizes, and are secured to the shaft by a taper cross-pin.

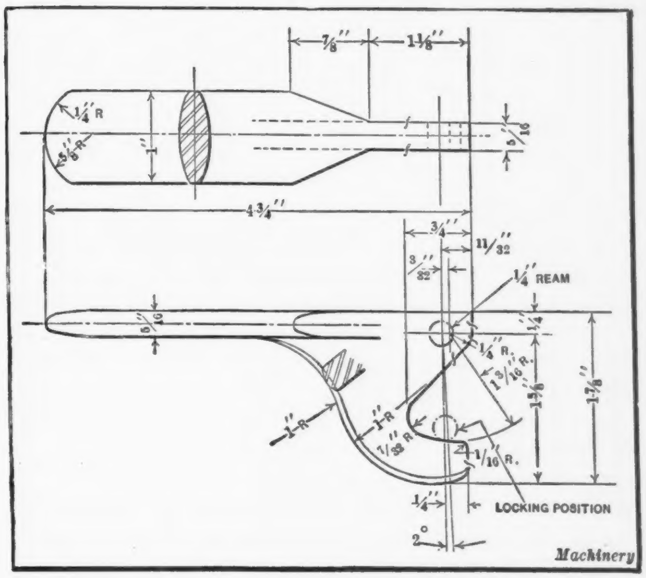
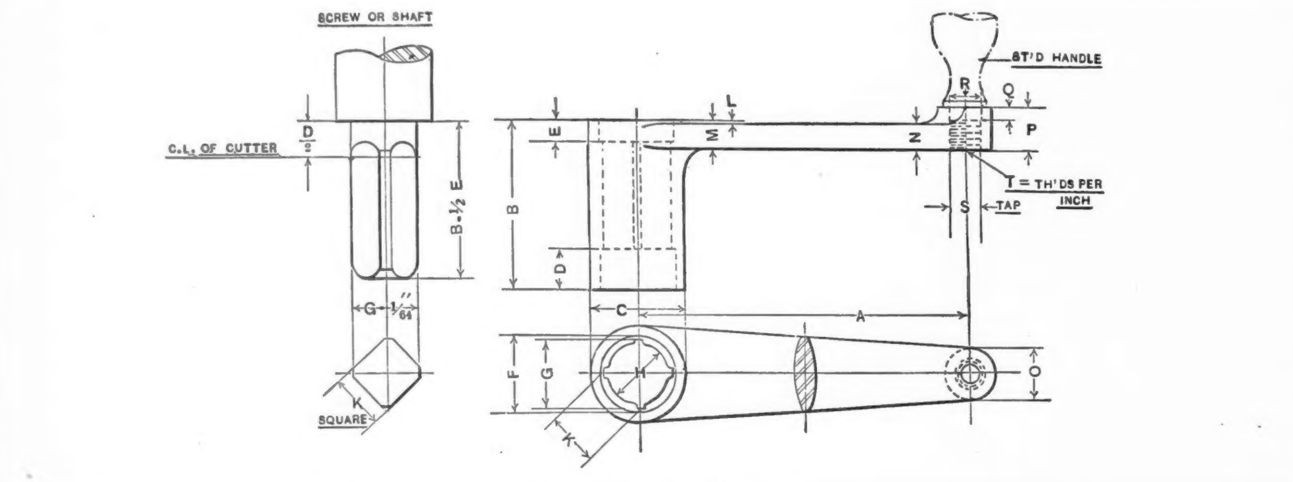


Fig. 3. Drill Jig Clamping Handle of the Cam or Eccentric Type

Shoulder Drill Bushings

Drill bushings of the shoulder type with holes varying from 1/16 to 1 inch are covered by Table 2. These flanged or shoulder bushings are preferred by many tool designers whenever it is practicable to use them. The flange prevents any endwise movement of the bushing, such as might be caused by the action of the cutting tool. If this flange must be flush with the surface of the jig or fixture, it is let into a counterbored recess. These bushings are made of tool steel, hardened and ground.

TABLE 4. STANDARD CRANKS



A	B	C	D	E	F	G	H	K	L	M	N	O	P	Q	R	S	T	Handle*
4	2	1 1/8	1/2	1/4	21/32	5/8	17/32	1/2	1/16	11/32	11/32	5/8	1/2	1/8	7/16	3/8	24	2C
4	2	1 1/8	1/2	1/4	27/32	13/16	21/32	5/8	1/16	11/32	11/32	5/8	1/2	1/8	7/16	3/8	24	2C
6	2 1/2	1 1/2	5/8	5/16	29/32	7/8	23/32	11/16	1/16	13/32	11/32	3/4	5/8	3/16	1/2	3/8	24	3C
6	2 1/2	1 1/2	5/8	5/16	1 5/32	1 1/8	29/32	7/8	1/16	13/32	11/32	3/4	5/8	3/16	1/2	3/8	24	3C
8	2 3/4	1 5/8	5/8	5/16	1 3/32	1 1/16	27/32	13/16	1/16	7/16	3/8	7/8	5/8	3/16	1/2	3/8	24	4C
8	2 3/4	1 5/8	5/8	5/16	1 7/32	1 3/16	31/32	15/16	1/16	7/16	3/8	7/8	5/8	3/16	1/2	3/8	24	4C
10	3	1 3/4	3/4	3/8	1 7/32	1 3/16	31/32	15/16	1/16	1/2	7/16	1	3/4	3/16	5/8	1/2	16	5C
10	3	1 3/4	3/4	3/8	1 13/32	1 3/8	1 3/32	1 1/16	1/16	1/2	7/16	1	3/4	3/16	5/8	1/2	16	5C
12	3 1/4	2 1/4	3/4	3/8	1 13/32	1 3/8	1 3/32	1 1/16	1/16	1/2	7/16	1 1/8	3/4	3/16	5/8	1/2	16	5C
12	3 1/4	2 1/4	3/4	3/8	1 21/32	1 5/8	1 9/32	1 1/4	1/16	1/2	7/16	1 1/8	3/4	3/16	5/8	1/2	16	5C
15	3 1/2	2 1/2	3/4	7/16	1 27/32	1 13/16	1 13/32	1 3/8	1/16	9/16	1/2	1 1/4	15/16	1/4	3/4	5/8	16	6C
15	3 1/2	2 1/2	3/4	7/16	2 1/32	2	1 17/32	1 1/2	1/16	9/16	1/2	1 1/4	15/16	1/4	3/4	5/8	16	6C

Machinery

*See Table 5 for dimensions of handles.

Binder or Clamping Handles—Cranks

Table 3 applies to binder handles, having (1) plain holes with cross-pins, (2) tapped holes, and (3) either plain or tapped holes located at an angle to the handle. The left-hand half of the table gives the general dimensions, and the right-hand half covers the diameters of plain holes, the

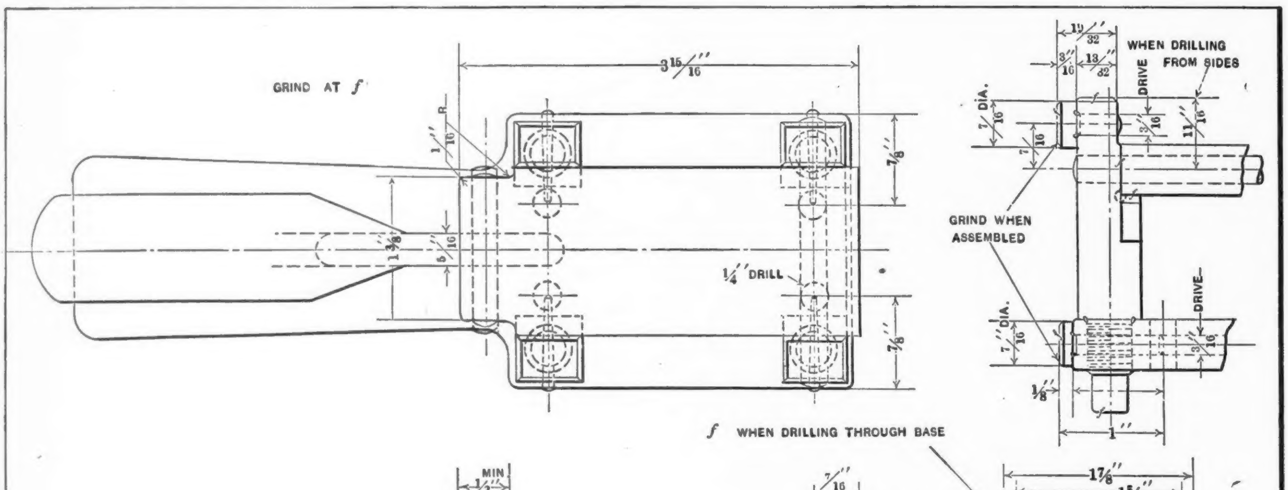


Fig. 4. Drill Jig equipped with a Cam-handle and a Standard Base

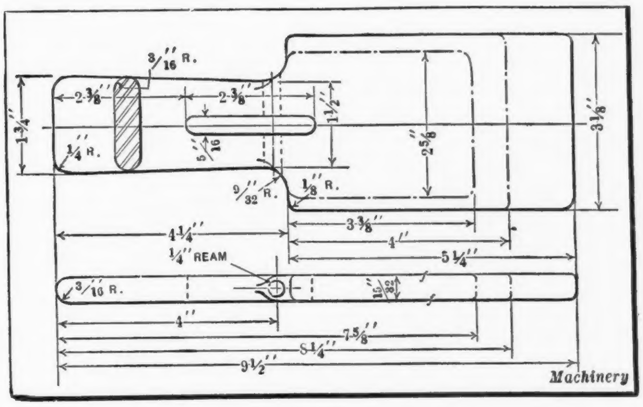


Fig. 5. Standard Bases for Drill Jigs

taper pin drill numbers, the diameters of tapped holes, and the corresponding threads per inch.

Dimensions for different sizes of cranks of the type used for turning adjusting screws, etc., are given in Table 4, which also includes the dimensions of the squares on the screw or shaft. Dimensions for the handles used in connection with these cranks are given in Table 5, which includes additional sizes.

Cam-handles and Drill Jig Bases

A clamping handle of the cam or eccentric type, which has been extensively used, is illustrated in Fig. 3. This is made from a tool-steel forging, and the cam end, which engages a clamping pin, is hardened and tempered. The style of base used in conjunction with this cam-handle is shown in Fig. 5, which gives the dimensions of three standard sizes. The base is made of machine steel, and the sides are ground as indicated by the finish marks. Fig. 4 shows a drill jig equipped with a cam-handle and a standard base. This is the smallest jig of the series, there being medium and large sizes which make use of the medium and large sized bases shown in Fig. 5.

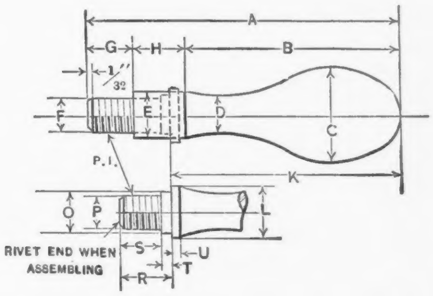
Binder and Centering Plugs

Sometimes it is practicable to standardize an entire unit, consisting of several assembled parts. Such a case is shown in Fig. 6, which illustrates the binder and centering plug for a fixture used for holding rifle bolts. The clamping action is derived from a helical cam surface *A* on the binder sleeve, which engages a block *B* attached to the body of the fixture. When the handle at the end of the binder sleeve is swung to the open position *C*, the projecting end of stop-screw *D* seen above the binder sleeve is opposite a longitudinal slot *E*, thus permitting the sleeve to be moved back far enough to insert or remove the work. The latter is held and centered by a plug at one end and a bushing at the other. The same style of binder, modified as regards center and plugs or minor details, is applied to various fixtures.

STANDARDIZATION WORK IN JAPAN AND NORWAY

Standardization work in Japan has recently been given a great impetus by the organization of the Japanese Engineering Standards Committee. The main function of this committee is to serve as a bureau for solving problems involving engineering standardization. The committee consists of seventy members, and the Minister of the Department of Agriculture and Commerce serves in the capacity of president. The details of the work of standardization are handled by seven secretaries who are engineers of the government departments of Agriculture and Commerce, Communications, Railways, Military Engineers and Naval Engineers. The work is being pushed with vigor, investigations already being under way on metals, woods, bricks, screws, electric wires, and electric motors. In Norway a national standardization committee has been organized by the Federation of Norwegian Industries. One of the first projects which is to be taken up by the new committee, after the necessary work on organizational problems, is the standardization of ship machinery and ship details.

TABLE 5. STANDARD HANDLES



No.	A	B	C	D	E	F	G	H	Thds. per In.
0	2 5/8	1 15/16	13/16	11/32	15/32	5/16	5/16	3/8	28
1	2 15/16	2	15/16	13/32	15/32	3/8	3/8	9/16	24
2	3 7/16	2 3/8	1	7/16	1/2	3/8	1/2	9/16	24
3	3 15/16	2 13/16	1 1/8	15/32	19/32	3/8	1/2	5/8	24
4	4 1/4	3 1/8	1 1/4	1/2	19/32	3/8	1/2	5/8	24
5	4 3/4	3 7/16	1 5/16	9/16	21/32	7/16	1/2	13/16	20
6	5 3/16	3 5/8	1 7/16	5/8	3/4	1/2	11/16	7/8	16

No.	K	L	O	P	R	S	T	U	Thds. per In.
2C	2 17/32	9/16	7/16	3/8	9/16	29/64	7/64	3/32	24
3C	3	5/8	1/2	3/8	11/16	33/64	11/64	5/32	24
4C	3 3/8	11/16	1/2	3/8	11/16	33/64	11/64	3/16	24
5C	3 13/16	7/8	5/8	1/2	53/64	21/32	11/64	3/16	16
6C	4 1/8	1	3/4	5/8	1 1/64	25/32	15/64	1/4	16

Machinery

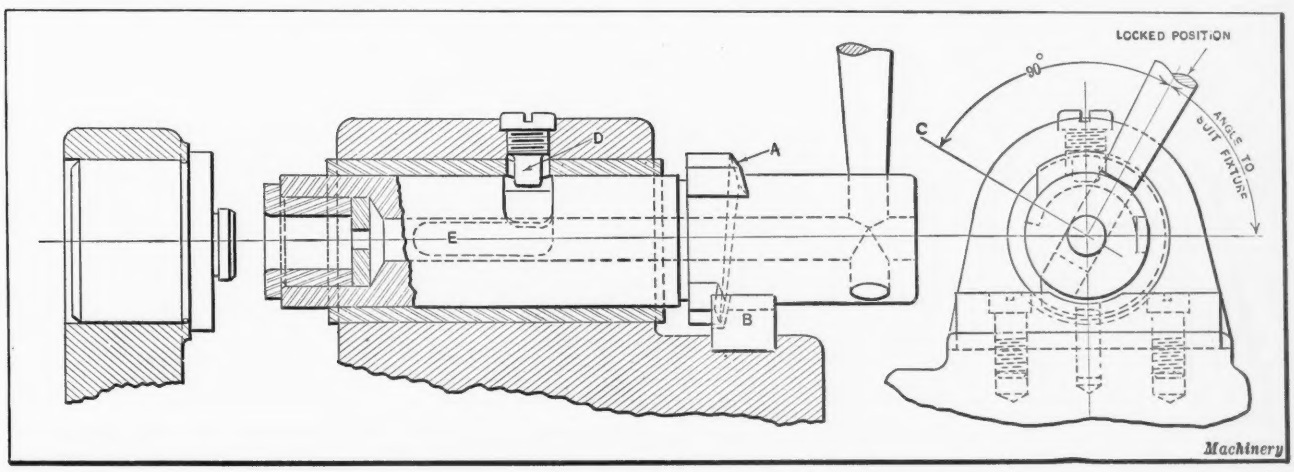


Fig. 6. Example of Standardization applied to a Binder and Centering Plug for a Fixture

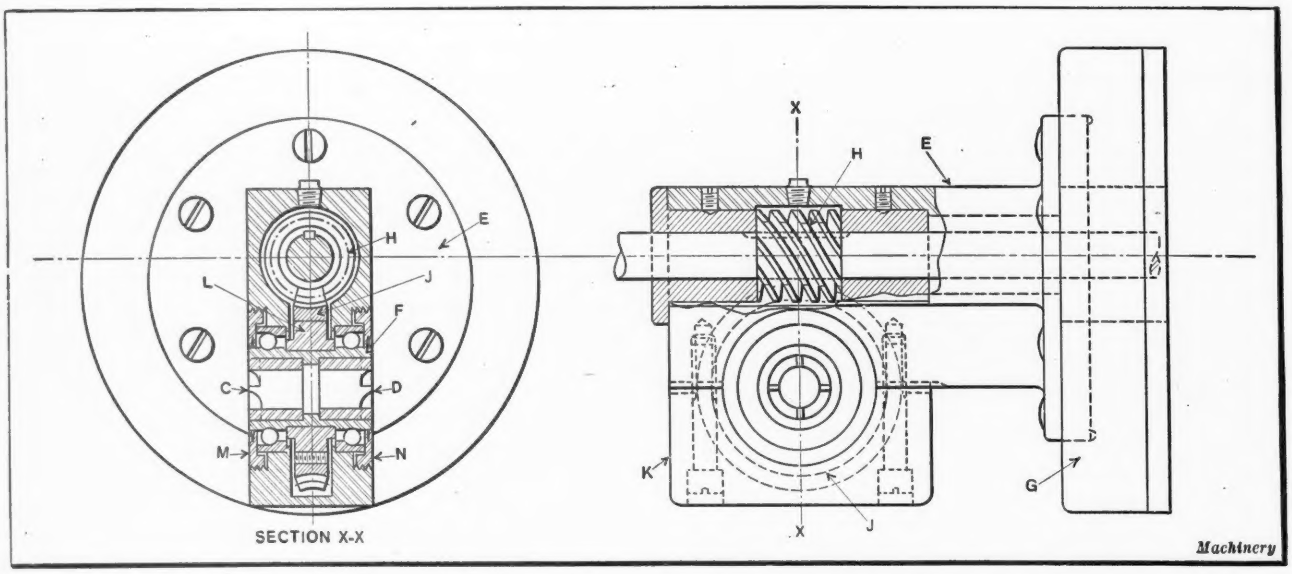


Fig. 1. Auxiliary Spindle carrying Hollow-mills for machining Trunnions A and B of Forging shown in Fig. 2

MILLING SHIFTER FORK TRUNNIONS

By A. H. SCHWAB

In the production of automobile shifter forks, such as shown in Fig. 2, it is necessary to turn the trunnions or bosses *A* and *B* to a diameter of 19/32 inch. The milling machine attachment shown in Fig. 1 was designed for use in performing this operation. This fixture is provided with two hollow-mills *C* and *D*. The axis of the short hollow spindle *F* on which the high-speed milling cutters are mounted is at right angles with the main spindle, and parallel with the milling machine table. Thus, while held in the fixture illustrated in Fig. 3, the work can be fed first to the right for milling the boss or trunnion *B*, and then to the left for milling trunnion *A*.

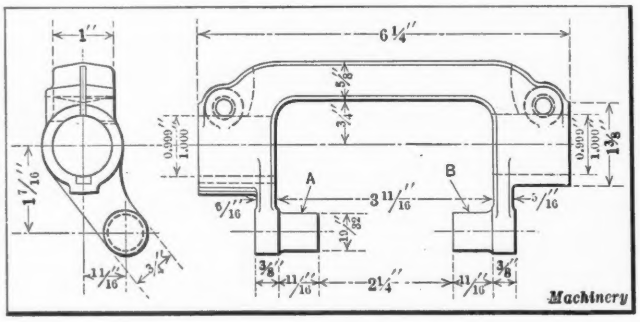


Fig. 2. Automobile Shifter Fork

Referring to Fig. 1, *G* is a cast-iron ring which is bolted to the milling machine. The worm *H* and the worm-wheel *J* are held in a steel housing *E* that is bolted to ring *G*, a recess being cut in the latter part to receive the flange of housing *E*. The housing is bored out to receive the milling machine arbor and is provided with bushings which support the worm and take the thrust. The ball bearings in which hollow spindle *F* is mounted are held in place by cap *K* and the threaded side plates *M* and *N*. Worm-wheel *J* is bored out to enable it to pass over the ball bearing races in order to facilitate assembling. Bushing *L* is made in two pieces so that it fits the recess cut in spindle *F*. Cap *K* is held in alignment by two sets of keys located at right angles to each other.

The hollow-mills *C* and *D* have bayonet slots milled on one side to permit rapid attachment to, or removal from, the spindle. These milling cutters run at 200 revolutions per minute. The fixture shown in Fig. 3 for holding the work is of simple construction and requires very little explanation. The work is placed in this fixture, and locating mandrels *P* and *Q* are pushed into place to support the work as shown. The wing-nuts are then tightened on hook-bolts *R* and *S*, thus clamping the trunnion-carrying arms of the work against set-screws *T*. Screws *U* and *V* are brought into contact with the work to support it against the thrust of the cut.

* * *

The United States Geological Survey estimates that our reserves of petroleum approximate 9,150,000,000 barrels, which is said to be enough to last only twenty years.

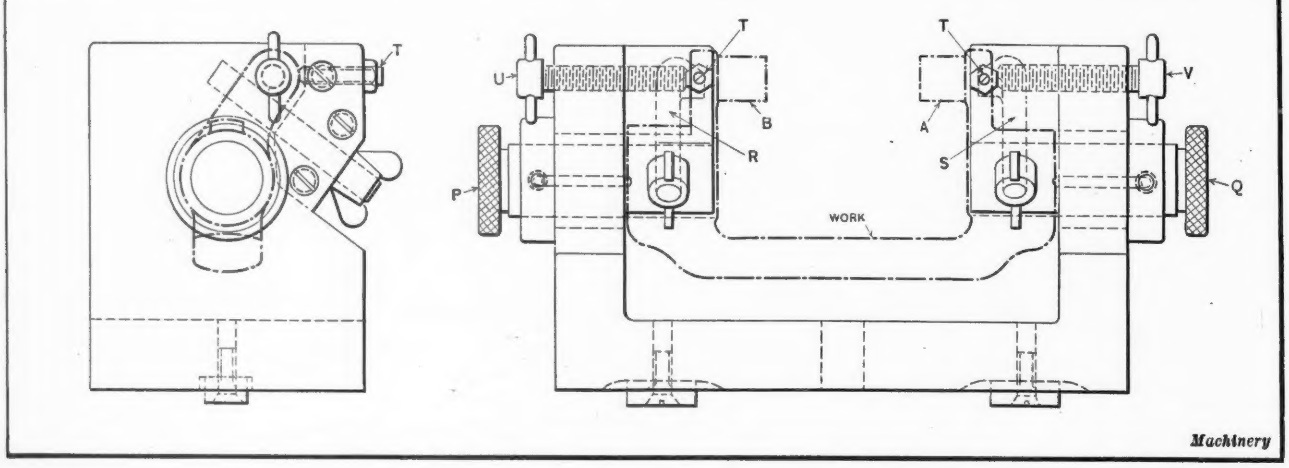
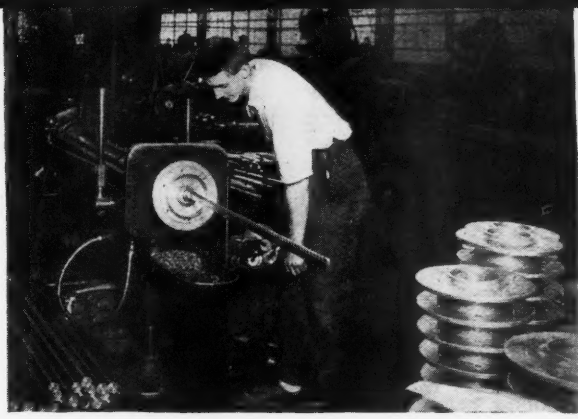


Fig. 3. Fixture for holding Shifter Fork shown in Fig. 2 while milling

The Design of Pull Broaches



Depth of Cut—Pitch—Length—Shape of Teeth—Methods of Attaching Broaches to Machines

By J. LABENSKY and PALMER HUTCHINSON

THERE are few shops that make a practice of manufacturing their own broaching tools, even the larger users of broaching machines having, as a rule, taken the making of broaches away from their own tool-rooms and turned it over to one of the concerns that make a business of manufacturing these tools. This fact is somewhat surprising when one considers that broaches can seldom be purchased from stock like drills, reamers, taps, and dies, but must be made up individually after an order has been placed. This practice may be attributed to the fact that many tool draftsmen are not familiar with the principles governing broach design.

Details in the design of the more widely used styles of broaches have been compiled as empirical data by all the better known broach manufacturers, and although the necessity constantly arises for the design of special tools for which there are no such data, broach usage has progressed far enough for the designer to be able to combine experience gained in making the more common broaches with mechanical common sense, and lay out special broaches that will in nine cases out of ten work successfully when coupled to the draw-head of a machine.

Depth of Cut per Tooth

The first consideration in designing a broach is the amount of stock to be removed from the work by each cutting tooth of the tool. This varies with the material to be cut, the type of broach, and, in some cases, with the length of work, power of machine, and size of broach. When the term "depth of cut," is used in reference to round broaches, it means the total increase in the diameter of a tooth; when referring to spline broaches, the total increase in the diameter of a circular series of teeth; to square, hexagonal, and rectangular broaches, the increase in the measurement across the corners of the teeth; and to keyway cutter-bars, the increase in the height of each tooth. The depths of cut which have proved satisfactory for general cases are given in the following:

ROUND REAMER BROACHES

For steel	0.001 to 0.0015 inch
For brass	0.002 to 0.003 inch
For cast iron	0.002 to 0.003 inch
For babbitt	0.003 to 0.005 inch

SPLINE BROACHES

Ten-spline	0.003 to 0.004 inch
Six-spline	0.003 to 0.005 inch
Four-spline	0.004 to 0.006 inch
Two-spline	0.005 to 0.006 inch
One-spline	0.002 to 0.003 inch

SQUARE, HEXAGONAL, AND RECTANGULAR BROACHES

For steel	0.0035 to 0.004 inch
For cast iron	0.0045 to 0.006 inch

KEYWAY CUTTER-BARS

For steel	0.003 inch
For cast iron	0.004 inch

Pitch of Broach Teeth

The second consideration in the design of a broach, and one of great importance in that the successful cutting action of the tool depends in a degree upon it, and because many of the other broach dimensions are derived from it, is the pitch. Pitch, in its relation to broaches, is defined as the distance between successive teeth, and this distance is controlled by several factors. The pitch determines in part the length of the broach, and so should be made as fine as possible if maximum production is to be attained, because with the modern adjustable-stroke broaching machine, production varies inversely with the length of the cutting tool.

There are limitations, however, to the fineness of the pitch. In the first place, the pitch must be coarse enough to allow ample chip room between the teeth. It will be obvious in this connection that the depth of cut per tooth governs the pitch somewhat. Theoretically, a round broach designed to ream babbitt would have a greater distance between its teeth than a round broach designed to ream steel, because the babbitt-cutting tool would be made to remove a heavier chip than the steel-cutting tool. In practice, this statement would hardly hold, but it is a fact that an ordinary broach has only sufficient room between its teeth to carry off the chips from one cutting stroke. It is for this reason primarily that broach makers emphasize the necessity of brushing the chips from a broach after every stroke of the machine. A few chips left on the tool combined with those of the succeeding cut may tear the work or break the tool. Generally, however, if the other factors that control the pitch are considered, the matter of chip room will take care of itself.

There must always be two, and there should preferably be three, cutting teeth in the work at a time; otherwise, the part being broached will drop down between the teeth. This difficulty may be eliminated, and often is when several thin pieces are stacked for broaching at one stroke, by affixing a support to the faceplate of the machine, which will hold the work rigidly in place. While the number of teeth in the work should never be less than two, there should not be an excessive number cutting at one time. If this is the case, the stress on the tool will be beyond the breakage point or the driving nut of the machine will become heated. Although the amount of pull available at the draw-head of a broaching machine may be readily measured or calculated, there are no adequate data or formulas for determining the power needed to pull the countless sizes and types of broaching tools through the various materials that are broached —from fiber to nickel steel.

From the foregoing it may appear that a draftsman, in deciding on the pitch of a broach, faces a somewhat complicated problem, but such is not the case. Practice has proved

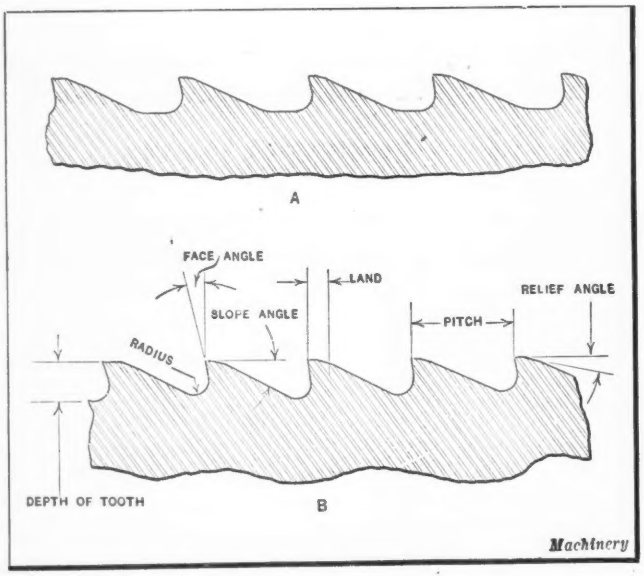


Fig. 1. (A) Flatted Spaces between Broach Teeth; (B) Nomenclature of Broach Teeth

that if the number of broach teeth in the work at a time is somewhere between three and six, all of the considerations relative to pitch are satisfied and the tool will function properly. The broach designer need merely divide the length of the work that the prospective tool is to cut, by a constant in order to determine the pitch, which is calculated to the nearest 1/16 inch. This constant is the number of teeth that should be in the work at one time, and is as follows for several types of broaches: Square broaches, from 3 to 5; spline broaches, from 3 to 6; keyway cutter-bars, from 3 to 6; round broaches, 3; and special-shaped broaches, 3.

Few commercial broaches are made with the pitch over 1¼ inches, and by far the greater part of the work for which broaches are used is less than 10 inches in length. When the work is over 4 inches long, the designer adopts a plan which permits him to keep the pitch 1¼ inches or under in the majority of cases. Teeth 1 inch or more apart are rugged enough to permit the back to be machined away considerably without weakening them to the breaking point; hence the bottoms of spaces between broach teeth of 1-inch pitch and over are usually flatted as shown at *A*, Fig. 1, to give the necessary additional chip room for long work.

Length of Broaches

After the depth of cut per tooth has been determined, the total amount of material to be removed by a broach is divided by this decimal to ascertain the number of cutting teeth required. This number of teeth multiplied by the pitch gives the length of the active portion of the broach or the distance that the tool must taper. By adding to this dimension the distance between three or four straight teeth, the length of a pilot to be provided at the finishing end of the broach, and the length of a shank which must project through the work and the faceplate of the machine to the draw-head, the over-all length of the tool is found. This length is often greater than the stroke of the machine or greater than it is practical to use for a tool of the diameter in question. In such cases, a set of broaches must be used; two, three, four, and five broaches are often necessary to machine a single piece of work, while a set of forty-eight broaches was made during the war to machine the dovetail slots in the recoil cylinders of the U. S. Army 4.7-inch guns. Simple formulas for determining the length of the more common types of broaches in accordance with general practice will be given in the following. In these formulas,

L = length of broach;
S = constant for length of shank (5½ to 6 inches);
W = length of work;
P = pitch of teeth;
T = number of cutting teeth;
B = allowance for sizing teeth on reamer broaches for steel (4 inches); and
F = allowance for pilot on finishing end (¾ to 1 inch).

Round broaches for reaming babbitt or bronze are most often designed with a guiding tooth following each pair of cutting teeth as shown at *A*, Fig. 2. When this is done one of the guiding teeth must always enter the work before the two preceding cutting teeth have left and must not leave the work before the following cutting teeth have entered. Each guiding tooth is made 0.0005 inch less in diameter than the cutting tooth ahead in order to compress the metal and keep the broach from drifting. The reason for making the diameter of the guiding tooth less in diameter than the preceding cutting tooth is because the diameter of the hole becomes less after the cutting tooth passes by, due to the expansion of the metal. The width of the guiding teeth is normally equal to the pitch. The teeth have rounded shoulders instead of keen cutting points, and are neither relieved nor under-cut. Sometimes the guiding teeth are of button shape. This type of tool carries a row of button teeth as shown at *B*, or a long straight section, at the finishing end for burnishing the work. This arrangement gives a compressed and glossy finish to the broached surface. The formula for finding the length of broaches of the type shown at *A* is as follows:

$$L = S + W + 2PT + 8P$$

while for broaches of the type shown at *B*, the length is

$$L = S + W + 2.25PT + 8P$$

Reamer broaches for steel are frequently made similarly to the broaches for softer metals, but are more often made without guiding teeth. In the latter case it is customary to leave three or four straight teeth of the regular pitch at the end of the tapered section, followed by sixteen teeth of equal diameter ¼ inch apart, as shown at *C*. Since these teeth do not remove metal, their pitch may be made as fine as desired. The formula for the length of such a broach is as follows:

$$L = S + W + PT + 3P + B + F$$

The length of square and spline broaches may be determined by the formula:

$$L = S + W + PT + 3P + F$$

The formula for the length of keyway cutter-bars is:

$$L = S + W + PT + 4P$$

Shape of Broach Teeth

In deciding upon the shape of the broach teeth, the considerations are depth of tooth, width of land, radius at base, and the two main tooth angles, which are the face or cutting angle at which the teeth slope forward from the vertical plane, and the slope angle to which the backs of the teeth

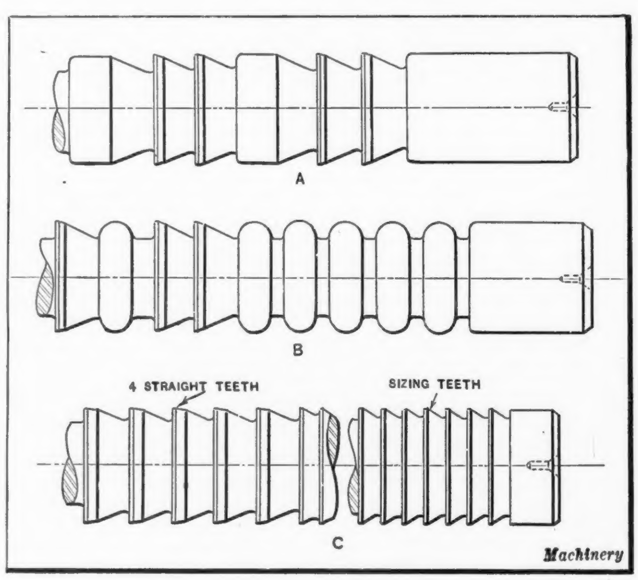


Fig. 2. (A) and (B) Broaches for Soft Metals such as Bronze and Babbitt; (C) Broach for Steel

are ground. This nomenclature will be understood by referring to the diagram at *B*, Fig. 1. The slope is relatively unimportant, as it is developed by connecting the rear of the land with the base of the succeeding tooth before the radius at the base is decided upon. The depth of tooth is usually made from one-third to a maximum of one-half the pitch. On a round broach of ¾-inch pitch, for example, from ¼- to ⅜-inch depth of stock would be removed.

The land of broach teeth, as illustrated, is the partially straight and partially angular top of the teeth. It varies in width with the pitch and, on occasions, with the hardness of metal that the broach is to cut. The wider the land, the more times a broach can be sharpened without reducing its size. Consequently, there is a tendency among uninitiated broach users to demand that the tools be made with lands of excessive width; however, if the lands are made too wide for a given pitch they cause the teeth to drag and tear into the work. The following relations between the width of land and pitch have proved satisfactory for general cases:

Pitch, Inches	Width of Land, Inches
¼	1/32
⅜	1/32 to 1/16
7/16 to 11/16	1/16 to 3/32
11/16 to 1¼	⅛

The land is backed off or relieved to an angle of 1½ or 2 degrees for a part of its width, leaving usually from 1/64 to 1/32 inch absolutely flat or parallel to the tool axis.

The arc at the base of broach teeth is by no means a matter to be neglected, either by the designer or by the shop. The shape of this arc must be such as to cause the chip to roll into a compact curl as it is forced down from the cutting point of the tooth. Should the chip strike a flat surface at the base of the tooth, there would be a tendency for it to shatter and be forced out from the space between the teeth. This radius can be determined graphically by simply drawing a smooth curve after the lines defining the face of one tooth and the rake of the preceding tooth have been drawn in. Ordinarily, it will be found that a radius equal to one-half the depth of the tooth gives the desired curve.

The face angle of broach teeth varies with the hardness of the metal to be cut, and determines the cutting keenness of the tool. Teeth on a broach designed for cutting steel usually slope forward from the vertical at an angle of from 8 to 12 degrees while some slope as much as 14 degrees. For cutting softer metals, such as babbitt or bronze, the face angle is decreased to from 4 to 6 degrees. Broaches for cast iron have the tooth faces ground at an angle of from 6 to 8 degrees in the majority of cases. Efficient broach sharpening demands that the disk wheel of the grinding machine be set to the face angle of the broach teeth and that the sloping surfaces be lightly skimmed with the abrasive, to maintain this face angle throughout the life of the tool.

Methods of Attaching Broaches to Machines

The final consideration in laying out broaching tools is the means of connecting the tool shank to the draw-head of the machine. There are numerous designs of broach shanks; a common type is the threaded shank, the usefulness of which is limited to keyway cutter-bars or to broaches for machining external surfaces. Broaches of these types do not have to be removed from the machine after each cut. Fig. 3 shows a pull-bushing for a threaded shank broach, the shank being screwed into hole *A*. The large threaded portion of the pull-bushing fits the tapped hole in the draw-head of the machine. Keyway cutter-bars operate in a work-bushing or support. Their shanks are below the outside of the bushing, and so the work may be slipped on the bushing over the projecting end of the bar.

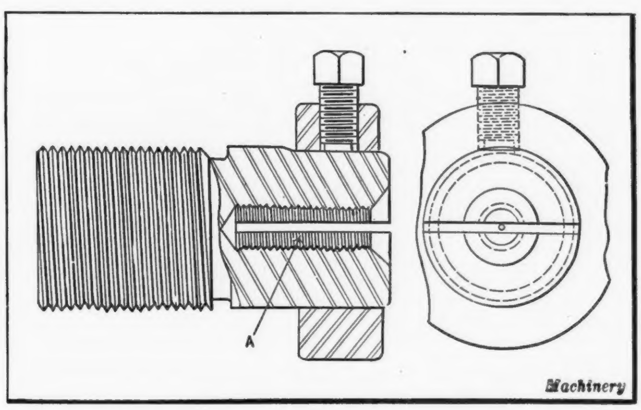


Fig. 3. Pull-bushing intended for Broach with Threaded Shank

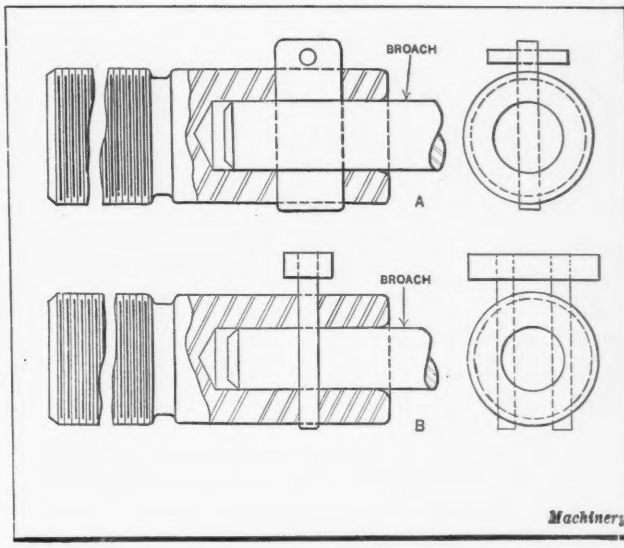


Fig. 4. Types of Pull-bushings employed when Broach must be removed after Each Operation

Round, square, hexagonal, spline, and other broaches for machining internal surfaces must be removed from the machine after each cut, and from the standpoint of rapid production it is, of course, impractical to thread the shanks of these classes of tools. Therefore, the shanks of the greater number of broaches in use have a rectangular slot at right angles to their axes. The shanks are inserted in a slotted pull-bushing attached to the draw-head of the machine, and are held in place by a hardened key as shown at *A*, Fig. 4. These shanks must fit snugly in the pull-bushing to prevent the tool from vibrating and possibly breaking under stress.

Many broaches of the sort that must be removed from the machine quickly have two semicircular recesses machined opposite each other on their shanks and at right angles to their axes. These shanks are held in the pull-bushing with a special key, as shown at *B*. This method is particularly applicable when the tools are comparatively light. Occasionally a broach which must be removed quickly is too small in diameter to permit the slotting or milling of recesses or flats on its shank, as in the last of the designs illustrated. In such a case it is the practice to thread the shank to a very fine pitch and grip it by a collapsible pull-bushing consisting of a cam and a split nut, so designed as to release the tool quickly when the cut is completed.

* * *

PROGRAM FOR A. S. M. E. SPRING MEETING

A tentative program for the spring meeting of the American Society of Mechanical Engineers to be held at Atlanta, Ga., May 8 to 11, has been issued. On Monday, May 8, a council meeting will be held in the morning, and the regular business meeting will be held in the afternoon. Tuesday morning, May 9, there will be a joint session of the Textile and the Machine Shop Sections, as well as a meeting of the Material Handling Section. A public hearing will also be held by the Power Test Codes Committee. Wednesday, May 10, there will be another joint session of the Textile and Machine Shop Sections, and also a meeting of the Fuel Section. Thursday, May 11, will be devoted to sessions on management, power, and welding.

Forming and Assembling Dies for Roll Cam

By W. B. GREENLEAF

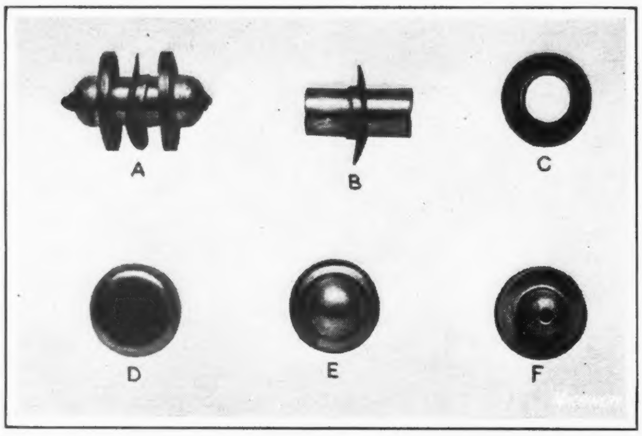


Fig. 1. Sheet-metal Products of Forming and Assembling Dies

THE dies described in this article are used in making parts for the roll cam shown at *A*, Fig. 1. The term "roll cam" is applied to this assembled unit for the reason that the two ends or caps serve as rollers, while the central member acts as a face cam. The central member *B* consists of a sheet-metal cylinder with a flanged sheet-metal disk *C* pressed over it, which is shaped in a forming die to give the face or cam surface the required contour. The end caps or rollers, one of which is shown at *F*, are pressed on the ends of the cylinder and must be a tight fit on this member. The assembled roll cam is about 1 1/16 inches long, and the roll ends are 25/32 inch in diameter. The cam has a throw of 0.100 inch. The stock from which these pieces are made is 0.017 inch thick.

Combination Blanking and Forming Die

In Fig. 2 is shown the combination die used to blank and perform the first forming operation on the cap shown at *F*, Fig. 1. The first forming operation is accomplished in two stages. After being blanked by punch *G* the continued downward movement of the press ram causes the blank to be formed over forming punch *H* to the shape indicated at *D*, Fig. 1, the relative positions of punch *G* and pressure-ring *I* being shown in the upper right-hand corner of Fig. 2. Ring *I* is just long enough to release the shell from all pressure between punches *G* and *H* at this stage.

The second stage of the forming operation, which forms the shell to the shape shown at *E*, Fig. 1, is completed at the end of the downward stroke of punch *G*. At this stage of the forming process, punch *G* has depressed pressure-ring *I* until it rests on the thin hardened steel washer *K*, and has forced the forming punch *H* and the heavier hardened steel washer *L* downward against the pressure of springs *M*. This action carries the blank down over the punch *N*, forming it to the shape indicated at *E*, Fig. 1. On the return stroke of the ram the blank is stripped from punch *N* by the forming punch *H* which is forced upward by pins *O*, actuated by springs *M*. Pressure-ring *I*, actuated by spring *J*, and acting through the four pins *P*, strips the blank from forming punch *H*. At the end of the upward stroke, knock-out *Q* comes into action and ejects the formed shell from punch *G*. The shell now has the shape indicated at *R* in Fig. 2 and at *E*, Fig. 1.

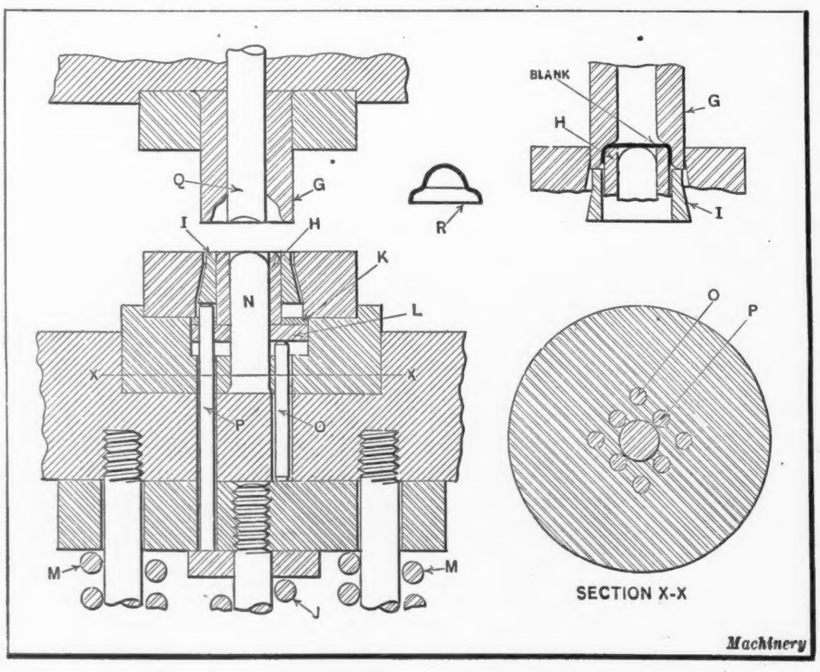


Fig. 2. Combination Blanking and Forming Die for Part F, Fig. 1

Piercing and Second Forming Punch

The piercing and the final forming operation which brings the piece to its finished form, as shown at *F*, Fig. 1, is performed by the die shown in Fig. 3. After being blanked and formed by the die shown in Fig. 2, the piece is placed on the die *T*, Fig. 3. On the downward stroke of the ram, punch *U* surrounds the outer edge of the flange of the work and holds it in the recess in the top of the die while the cap part is reduced to the proper size and the hole is pierced by punch *V*. At the end of the downward stroke sufficient pressure is exerted on the top of the flange to square the corners, flatten out any inequalities in the upper surface, and also flatten out irregularity in the edge caused by the drawing operation.

Blanking, Piercing, and Flanging Die

In Fig. 4 is shown a die for blanking, piercing, and turning up the flange on the cam blank shown at *C*, Fig. 1. The die- and punch-holders *A* and *B* are similar to those used in the dies in Fig. 2. The work is blanked by the tool-steel die *C* and pierced and flanged by die *D*. The tool-steel knock-out pad *E* is actuated by a spring *F*, acting through three pins, one of which is shown at *G*. The point of screw *H* projects into a slot in pad *E*, and thus serves to retain the latter member in the blanking die. *I* is the tool-steel blanking die, and *J* the piercing punch, which is supported in a machine-steel block *K*. The tool-steel knock-out pad *L* is a close sliding fit in punch *I*, and as it is also a close fit over punch *J*, it serves to support and keep the latter member in proper alignment. The two pins *M*, which pass through holes in washer *N*, are actuated by the press knock-out at the end of the upward stroke, thus causing the knock-out pad *L* to strip the work from the punch. From the illustration it will

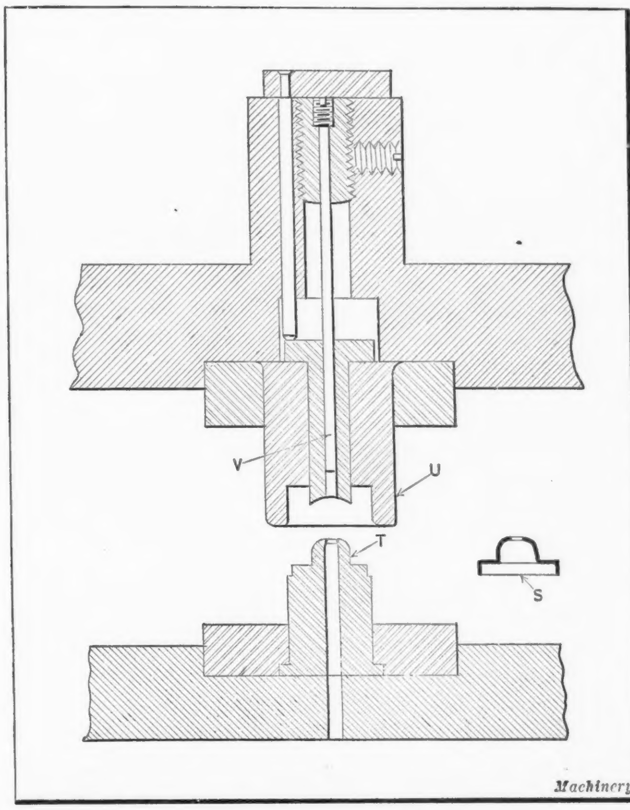


Fig. 3. Die for Piercing and Final Forming Operation

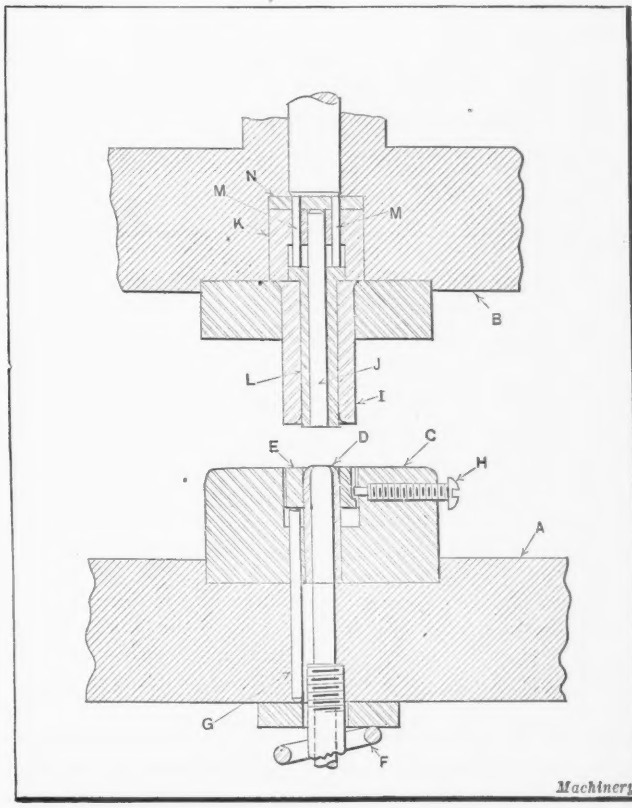


Fig. 4. Die for blanking, piercing, and turning up Flange

be evident that the center hole is pierced first, after which the piece is blanked and a flange formed as the punch continues downward. This die and the two previously described are used in inclined presses so that the pieces drop out at the back.

Assembling Die

In Fig. 5 is shown the die employed to assemble the flange *C*, Fig. 1, on the metal cylinder, and at the same time give the face or cam surface the required contour. In operating this die, the cam-plate is set on die *A* with the flange down and fitting into the recess provided for it. The cylinder is then inserted in die *B*, in which it is a loose fit. The cylinder also fits snugly over the end of punch *C*, which serves to hold it in position. On the downward stroke of the press ram, the cylinder is driven through the cam-plate until it rests in the seat in die *A*. While the piece is held in this position the punch or mandrel *C* passes through the entire length of the cylinder.

The final step in the assembling operation is the bending of the plate into the form of the cam. This bending also contracts the hole so that the flange grips the cylinder with sufficient force to hold it in this position. It should be mentioned here that the end of die *B* is formed to the shape of the cam contour, as is also the mating surface on die *A*, although this is not shown in the illustration.

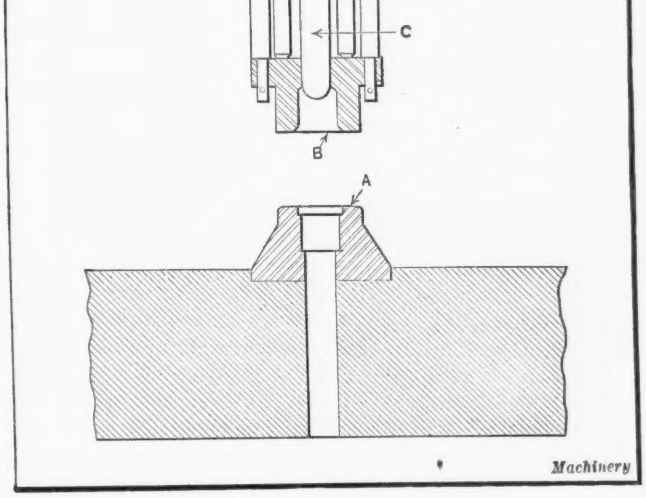


Fig. 5. Assembling and Cam-forming Die

CALITE—A HEAT-RESISTING ALLOY

Calite, an alloy containing iron, chromium, nickel, and aluminum, is the result of experiments conducted by metallurgists of the General Electric Co., for the purpose of finding an alloy that would withstand high temperatures, could be quenched repeatedly, and would be highly resistant to oxidation. Annealing boxes made from calite have been run for 1500 heat-hours without warpage, growth, or failure. The metal runs freely when molten, and any casting which can be made of steel can also be produced from this alloy. Sections as low as 3/16 inch in thickness have been successfully cast. Calite cannot be machined in the cast condition nor cut with an oxy-acetylene torch; hence, it must be finished by grinding.

This new alloy is said to resist oxidation up to about 2375 degrees F., but a working temperature of 2200 degrees is recommended. Calite is practically non-corrosive, samples having been polished and subjected to a spray of saturated sea-salt solution at 100 degrees F. for 200 hours without any effect on the polish. The physical properties are: Melting point, 2780 degrees F.; softening temperature, 2500 degrees F.; specific gravity, 7.03; weight per cubic inch, 0.25 pound; Brinell hardness when annealed, 286; scleroscope hardness when annealed, 40; thermal conductivity, 25 per cent that of iron; and tensile strength, 36,800 pounds per square inch.

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NEW TOOLMAKING CENTERS

In June MACHINERY an article reviewed the gradual westward movement of the machine tool industry, which forty years ago was almost entirely located in New England, New York, New Jersey and Pennsylvania. During the interval, the industry so developed in the Middle Western states that at the present time a line drawn north and south through Rochester, N. Y., would divide the machine tool building business almost equally.

In the making of jigs, fixtures, power press dies, gages and small tools, New England also had but little competition until recent years; but many plants of considerable size producing such tools are now located in the Middle West. This is a natural result of manufacturing conditions in the Middle West, where there are many large plants that require special tooling equipment, the manufacture of automobiles being centered in Detroit; and large plants are located throughout Michigan, Ohio, Indiana and Illinois. Within the last ten years several of the cities in these states have become important tool-building centers, particularly Dayton, Columbus and Urbana, Ohio; Detroit and Chicago. Some of the plants in these cities have been very highly developed for the purpose of building special tools, partly because of the exacting requirements of the automobile business and partly because of the demand for tooling equipments and gages for war materials and munitions during the war. Entirely new tool building centers have been developed to supply the demands of the great Middle Western territory, which, during the last two decades, has developed so rapidly in metal-working and manufacturing. Meanwhile, New England tool manufacturers continue to hold their own, the increased industrial activities of recent years providing an outlet for the greater tool building capacity.

* * *

THE CENSUS OF MACHINE TOOLS

February MACHINERY recorded for the first time in the history of the industry the census figures giving the total number of machine tools of various types built in this country, and their value. The Department of Commerce has done the industry a distinct service by compiling these statistics, for such information is of practical value to our manufacturers. The statistics published covered 1919, but in future a similar census will be taken every other year. The Bureau of Census is now collecting figures covering the production in 1921; and, as such information loses value by delay in publication, it is hoped that this material will be available for publication much sooner than were the 1919 figures. Even with all the delay in the publication of those returns, the Bureau established a record for the prompt handling of such material.

Manufacturers should aid the Census Bureau to the utmost extent in collecting data of this kind. All information given to the Bureau is confidential, and only figures showing totals are published. No individual manufacturer's name is disclosed, and in case a manufacturer produces only a single line of machines so different in classification that it could be identified if grouped alone, it will be classed with a broader group of machinery so as to absolutely prevent the identification of any concern's output in the published report.

In addition to figures relating to production and the value of the product, the machine tool census in future will give the number of men employed and the percentage of employment in the industry. These statistics will refer not only to the entire country, but also to each of the most important machine tool manufacturing states. The information which the Census Bureau is endeavoring to supply has been needed greatly by machine tool manufacturers, and they should facilitate the work by making prompt returns on the blanks furnished them by the Bureau, which will thereby be enabled to give out the figures for early publication.

* * *

SYSTEMATIZED COST REDUCTION

In a well-known plant recently visited, a systematic effort is being made to improve manufacturing methods and reduce operating costs. A committee of the leading mechanical men is devoting its time during the prevailing depression to a thorough study of methods employed throughout the entire works. This committee takes up one department at a time, beginning with that where the raw material is received, and continuing its study all the way to and including the shipping department. The work is not done in a hurry, and no process or operation is considered too unimportant for careful thought. The department foremen are interviewed and their suggestions carefully noted, and the men operating the various machines are also given an opportunity to offer suggestions for increasing the output or improving its quality.

Much lost motion has been eliminated by improvements in methods, tooling equipment and machines. Sometimes the machinery is rearranged to facilitate the operations. Old machines have been scrapped and new ones to replace them investigated and decided on, even if not ordered.

Before changes are made, the practical points are usually talked over with both the foremen and operators, so as to insure their approval and cooperation. In this way harmonious relations are maintained, and when a new method is put into operation or a new machine installed, all do their best to help make it successful. This practical attempt at systematized cost reduction is not yet completed, but what has been accomplished so far shows that it is possible to reduce costs materially and meet the new level of prices at a profit. This method of reviewing the entire manufacturing process of a plant is easy to carry out under present conditions, and is recommended to manufacturers generally.

* * *

THE DEFINITION OF "DEDENDUM"

In spite of all the efforts to standardize engineering nomenclature, the meaning of many engineering terms is still vague and subject to different interpretations. A technical term without a definite and accepted meaning is likely to cause serious confusion, and an important step in standardization work is to agree on the precise definitions of terms.

In the gearing field the meaning of most of the terms used has been, through common usage, generally established, except the term "dedendum," which is used by some manufacturers and in some books of reference as meaning "the distance from the pitch circle to the root of the tooth," thus including the clearance allowed at the root; whereas others use the term as meaning "the distance from the pitch circle to the clearance circle." In the latter instance the dedendum, in standard-tooth gears, is equal to the addendum.

The American Gear Manufacturers' Association is giving serious consideration to the definition and standardization of terms used in gearing, and doubtless will soon settle what is actually meant by the term "dedendum."

Service of the Tool and Contract Shop

FIFTEEN years ago comparatively few shops were engaged exclusively in the designing and making of special tools, jigs, fixtures, gages, etc., on a contract basis for other manufacturers. Today there are a great many contract shops all over the manufacturing area of the United States, and some have so developed in size and reputation that they stand on a par with the great manufacturing shops. This remarkable development is due to the highly specialized service such shops can render, combined with a wider recognition of the importance of well-designed tool equipment as a means of increasing the efficiency of machine tools.

Toolmaking versus Manufacturing

All large manufacturing plants maintain tool designing departments and tool-rooms for designing and making the tooling equipment required in the regular manufacturing routine and for equipment maintenance; but it is usually found impracticable to maintain a designing force and a toolmaking department extensive enough to adequately meet the requirements for complete tooling equipments to put new products on a manufacturing basis. In cases of that kind it has been found more profitable to call in the tool specialist—the shop that devotes all its time to designing and building special tools, jigs, fixtures, and gages. In so doing the manufacturer utilizes the special experience of men trained in developing manufacturing equipment, men who from year to year handle manufacturing problems in many different industries, and acquire a knowledge of manufacturing problems much wider than can be obtained in any other way.

The Economy of Specialization

The tool and contract shop is simply a logical development of the modern principle of specialization in manufacturing. In the early days many manufacturers built their own machine tools for making machines for other purposes—in fact, some of the well-known machine tool builders in the country started as makers of other products—rifles, sewing machines, textile machinery, etc. In the course of time they found it necessary to develop machine tools for use in building these machines and devices, and ultimately they became known as machine tool builders rather than as makers of their original products. The time has passed, however, for the makers of other lines to undertake the manufacture of their own machine tools. It is far more economical to buy machine tools from those who specialize in them and who thereby have brought the American machine tool industry to the highest standard established anywhere in the world.

In regard to special tools, jigs, and fixtures, we are passing through a transition period. Up to a few years ago it was the common practice of all manufacturers to make most of their own tooling equipment—at least all equipment that could not be obtained directly from the manufacturers of machine tools. Now the tendency is more and more to have tooling equipments built by specialists in this branch, just as machine tools are built by specialists in that field. In New England and in the Middle West we find large shops devoted exclusively to supplying other manufacturers with tools, fixtures, and gaging equipments; and while years ago, when a new enterprise was started, the first thing was to find a corps of tool designers and toolmakers, today all this preliminary work may be handed over to shops especially fitted to do it. Hence, the plant can be equipped right from the start to do manufacturing instead of tool work.

Just as it makes for economy and efficiency to have specialists build machine tools, so it is found that it makes for economy and efficiency to have specialists design and make tooling equipments of all kinds. The next ten years will probably see a still further development along these lines, with a higher degree of specialization and consequently a greater degree of economy and service.

The Influence of the War upon the Tool Shops

The peculiar value of the tool shop became apparent during the war period, when many shops, unable to provide their own tools, were obliged to turn to outside sources for assistance. Hundreds of tool and contract shops were started during this period—a great many more, in fact, than could be profitably employed during normal peace times. Some of these are out of business, but many have survived and will continue. The experience they gained during the war period will prove invaluable to them and to the industries in peace times.

It is safe to say that the remarkable rapidity with which the United States entered into war production was due, in no small measure, to the experience, skill, and ability displayed by the tool and contract shops. Accuracy and refinement in mechanical processes were demanded of them to an extent never before required in interchangeable manufacture, and they measured up to these exacting requirements in a remarkable degree. Some of the accurate measuring and inspection devices now finding increased application in the mechanical industries were developed by the contract shops during this period. Methods of grinding threads, for example, were first placed upon a commercial basis in the making of thread gages in quantities for munitions and ordnance. Some of the very large machine tool plants, in fact, were turned into contract shops for the time being, and their main business consisted in supplying the war industries with the equipment required for manufacturing and inspection.

Standardization in Tooling Equipment

With the general development of the tool and contract service came definite efforts toward standardization in tooling equipments. While this work has not advanced very far yet, there is no doubt that the next few years will see great progress along these lines, which should materially reduce the cost of making jigs and fixtures. The contract shop with thoroughly standardized parts for such tools can produce a manufacturing equipment much cheaper than a toolroom in which each jig and fixture, and each separate part, must be made as a separate unit. The up-to-date contract shop has a great advantage and a real opportunity.

Another line along which standardization has progressed is in the making of interchangeable gage units of various types, so that when a gage unit which is subjected to the greatest wear becomes unsuitable for further use, this unit may be replaced. In the past, gages were generally so designed that when one part was worn, the gage was discarded.

The value of specialization in the tool equipment field cannot be over-estimated. The tool and contract shop has made a definite and highly important place for itself, a place that will become increasingly important with the multiplication of products and of manufacturing processes, and the realization of greater refinement in mechanical procedure. We have a well defined and well developed machine tool industry and a definite small tool industry, and it is confidently expected that within a few years we shall have a large and important tool equipment industry.

GAGING AND ASSORTING PISTON-RINGS

By HARRY LEVENE

In order to gage or measure accurately finished piston-rings of the regular split type, it is necessary to employ special gages and exercise considerable care in performing the gaging operations. A method of measuring piston-rings that has proved especially useful in separating an assortment of rings of the same nominal diameter into their respective over-size lots is described in the following. This method was developed by the Wilkening Mfg. Co., Philadelphia, Pa., and is used in this company's plant with excellent results.

In gaging or measuring a ring, it is first placed in a cylinder or gage of a known internal diameter. The diameter of the gage should be approximately equal to that of the ring. While performing this operation care should be taken to see that the ring lies in a plane perpendicular to the walls of the cylinder. One of the three following conditions will be observed when the ring is properly located in the gage: (1) The ring will fit the cylinder or gage properly; (2) the gap opening will be larger than the normal opening, showing that the ring is under size; and (3) the ends will be in contact or will overlap, showing that the ring is over size.

Ring of Correct Diameter

The normal gap of a ring is that gap G, Fig. 1, which exists when the ring is placed in a cylinder of exactly its own diameter. The width of this gap varies with the make of the ring, but 0.002 inch per inch of ring diameter represents an average value. If the measured gap of the ring fulfills this condition, the diameter of the ring is the same as the diameter of the cylinder.

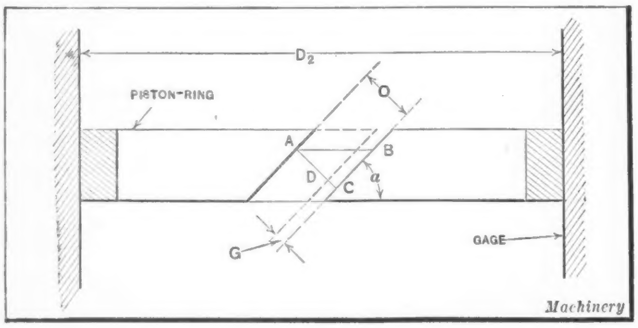


Fig. 1. Under-size Ring in Gage

Under-size Rings

When the opening is greater than the normal gap of the ring, it indicates that the diameter of the ring is less than that of the gage. The amount of the opening, that is, the distance between the ends of the ring, measured on a line at right angles to the angular surfaces of the ring ends, is determined to the nearest thousandth inch by means of a thickness gage. This value O, indicated in Fig. 1, the known values of gage diameter, and the angle at which the ring is split, are substituted in the following formula to find the diameter of the ring.

$$D_1 = D_2 - \frac{O - G}{\pi \sin a} \qquad (1)$$

in which D_1 = diameter of ring;
D_2 = diameter of gage;
G = normal gap of ring = DC;
O = opening = AC;
a = angle at which ring is split.

Over-size Rings

The third condition—the ends of the ring being in contact or overlapping as shown in Fig. 2—indicates that the diameter of the ring is greater than that of the gage. The amount of this overlap can be measured by means of a thickness gage, and substituting this value O, Fig. 2, in the formula

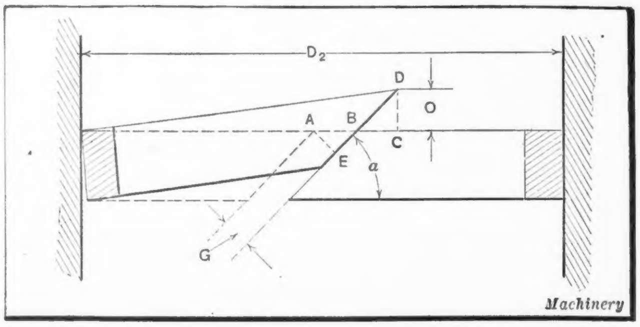


Fig. 2. Over-size Ring in Gage

$$D_1 = D_2 + \frac{G + O \cos a}{\pi \sin a} \qquad (2)$$

will give the diameter of the ring. In this formula,
D_1 = diameter of ring;
D_2 = diameter of gage;
G = normal gap = AE;
O = overlap = DC;
a = angle at which ring is split.

The angle at which the ring is split is usually 45 degrees, but it is occasionally made 30 degrees. If the angle is not known, it can, of course, be readily measured. Formula (2) for the third case is not applicable to step-joint rings or to any kind of ring in which the ends cannot slide upon each other. Formula (1), however, can be used for step-joint rings, such as shown in Fig. 3, in which case the angle at which the ring is split is 90 degrees, and the formula thus becomes

$$D_1 = D_2 - \frac{O - G}{\pi} \qquad (3)$$

Actually none of these formulas gives absolutely exact results, because they are based on the assumption that the ring will be in contact with the cylinder wall at all points on the circumference, but, nevertheless, they will prove of sufficient accuracy for practical purposes, provided the diameters of the gage and the ring do not differ by more than 0.040 inch.

The separation of an assortment of rings of the same nominal diameter into their respective over-size lots, is easily accomplished by using a gage having a diameter 0.040 inch over size, and employing Formula (1) for rings split on an angle, and Formula (3) for step-joint rings. All the factors in the formulas, except the diameter of the ring and the opening of the gap, remain constant. A table which gives the opening corresponding to each over-size diameter can be made up for this work. A table of this kind will give, without further calculation, the diameters of the over-size rings, and will greatly facilitate the work of separating the rings into different lots so that those of the same diameter will be grouped together.

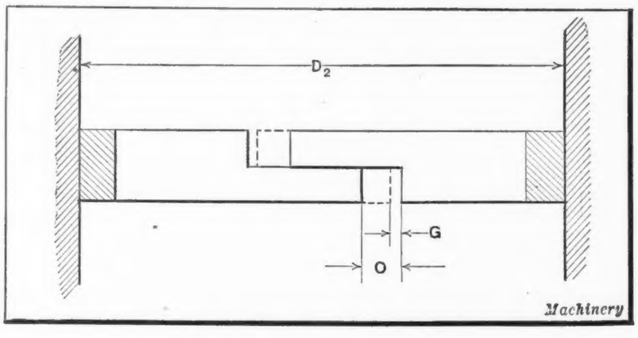


Fig. 3. Under-size Step Ring in Gage

The British Machine Tool Industry

From MACHINERY'S Special Correspondent

London, March 10

THE engineering industry in this country is dependent on the carrying out of several important projects that were delayed by the war. Chief among these is the conversion of many existing sections of railways, not only here but all over Europe, in the Far East, and in South America, from steam to electric power. The General Electric Co., Witton, has recently been awarded an important contract in connection with the extension of the electrified sections of the London Brighton & South Coast Railway, and several other English railways have similar projects that will soon be carried out. The machine tool industry is bound eventually to feel the good effects of these and other long delayed but far-reaching developments; at present, however, few direct results are to be noted.

General Industrial Conditions

During January there was a record output of shipbuilding, the total tonnage launched on the Clyde being 52,000. As very little new work is in hand, such an output brings the worst days nearer. There is some activity in the foundries and sheet-metal industry, aluminum, malleable and cast iron workers being in greater demand than for the last twelve months. Press-tool makers are also in demand.

C. A. Vandervell & Co., Ltd., the well-known manufacturers of electric lighting and starting equipment for automobiles, have undertaken at their Brighton works the manufacture of small tools on a quantity basis. Although they have been occupied with this work for only nine months, they already have a good output of a wide range of these tools, which include plain and spring type inside and outside calipers, spring dividers, toolmakers' parallel clamps, clamp vises, V-blocks, scribing blocks, tap wrenches, and toolmakers' squares.

British Industries Fair

Although the exhibits at the British Industries Fair, now being held in Birmingham and London, are too diverse to be truly representative of any trade, it is significant to note that the number of exhibitors is in excess of previous years and now totals over 500. The general engineering group of exhibits includes machine tools and small tools, hydraulic equipment, sheet-metal working machines, measuring and testing apparatus, heat-treating equipment, foundry, drop-forging and die-casting equipment, and conveying and lifting appliances.

The Machine Tool Trades Association, Inc., reports a successful year, and is able to point to much useful work on behalf of firms who are members of the association. The membership now stands at 142. In a recent ballot on the question of protecting the British machine tool market from being flooded with foreign machines, a motion was carried to the effect that the government should place import duties on all machine tools coming from countries where exchange values had collapsed. The Board of Trade is now giving consideration to these suggestions.

Foreign Trade

In foreign markets, India is the most active machine tool buyer, although of late there has been rather more demand from Australia and Japan. January showed, as compared with the preceding month, a slight increase in imports as well as in exports. The figures for the month were as follows: Imports, 275 tons, valued at £30,538, or £111 per ton. Exports, 1096 tons, valued at £167,021, or £152 per ton. A mean line taken through a graph of the exports of machine tools for last year shows that both in value and in tonnage exports declined at a steady rate, and at the end of the year were only half the figures for the beginning of 1921.

Iron and Steel Trades

The iron and steel trades are slowly reviving. Orders are coming in steadily from home consumers, and some fairly good business has been booked for overseas in the commoner varieties of steel. Crucible steels are also in better demand. It is reported that a further huge surplus stock of high-speed steel has recently been discovered at Constantinople, packed as it left the Sheffield Works some years ago for Russia. This adds to the heavy surplus, said to be sufficient to cover munition-making requirements for twenty years, which was discovered some months ago in the possession of the government. Apart from these stocks, the United States continues to be the best customer for high-grade steels, and there is a moderate demand from India and Japan; home inquiries are also becoming more numerous.

Better feeling prevails in the pig-iron industry, and makers are beginning to reap some benefit from their recent action in cutting prices. A number of important sales are understood to have been put through recently, and from present inquiries it appears that there is a fair amount of business to be placed by home consumers. A notable feature is the export of several thousand tons of pig iron to Germany. In amount the business is comparatively trivial, but this shipment is significant when it is remembered that during the greater part of last year conditions were such that Great Britain, from her former position as an exporter, came to be an importer. Thus the import figures for the three months ended December 1921, were 315,800 tons, as compared with a monthly average of 18,000 tons, during 1912-1913.

Conditions in the semi-finished material field are developing on similar lines. In the majority of cases British manufacturers have nothing to fear from Continental competitors in the overseas markets, and while India and Far Eastern countries are still taking German materials, the bulk of the business is passing into British works.

Developments in Machine Tools

Machines for cutting accurate gears are, perhaps, the outstanding development of recent years in the machine tool industry in this country. The advances are illustrated by statements recently made by leading gear-cutting machine manufacturers: J. Parkinson & Son, Shipley, state that one of their 5A rack type cutter machines will cut 132 feet of finished teeth per hour in cast iron, the gears machined having 156 teeth of 12 diametral pitch and 13/16 inch face. Muir & Co., Manchester, say that they are cutting in one of their rack type cutter machines 180 feet of ½-inch pitch teeth per hour, the cast-iron gears having 44 teeth, 1½ inches wide. On steel quadrants they are cutting 1½-inch pitch teeth, 5 inches wide, at the rate of 50 feet per hour. The Power Plant Co., Ltd., West Drayton, tells of cutting, in an 8½-hour day, 400 cast-iron gears having 14 teeth, 1¼ inches wide, of 6 diametral pitch. The machine was equipped for the purpose with six pinion type cutters operating simultaneously. The Power Plant Co., Ltd., has also aroused considerable interest with a one-tooth pinion meshing with a 63-tooth wheel. The pinion tooth is of the double-helical type and the pitch circle diameters are 0.508 inch and 32.004 inches, respectively. The gear has transmitted 10 horsepower at 1000 revolutions per minute.

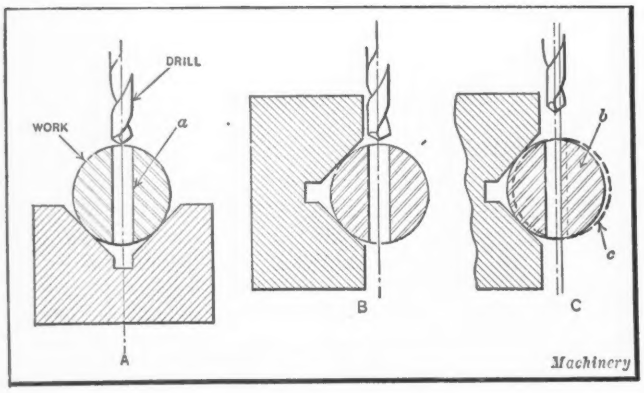


Fig. 1. Effect of Location of V-block on Accuracy of Work

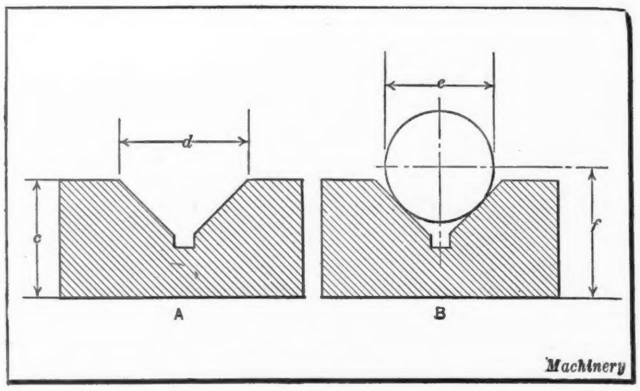


Fig. 2. Methods of dimensioning V-blocks

GENERAL DETAILS OF V-BLOCK DESIGN

By GENE PHELPS

The use of V-blocks in the design of tools often receives too little consideration from the designer. A careful analysis will show that many errors resulting from the incorrect application or design of V-blocks could easily be avoided. It is the purpose of this article to make clear the conditions that govern the use of various types of V-blocks in the shop, and to point out methods of avoiding the mistakes most commonly made by designers and draftsmen in designing V-blocks or in making provision for their use.

The limits of accuracy required on the work must first be considered, since this governs the general design. The view at *A*, Fig. 1, shows a round shaft in the position it occupies while the hole *a* is being drilled. In this view the V-block is shown in a horizontal position while at *B* it is shown tipped up, or in a perpendicular position. If the work is located and drilled as shown at *A*, any variation in its diameter does not affect the center line of the drilled hole, whereas if it is located as shown at *B*, a variation in diameter results in throwing the center of the work out of line with the center line of the drill. In the view at *C*, work *b* is of the correct size, while that indicated by the dotted lines at *c* is a little over-size. It will be apparent that a difference of 0.002 inch in diameter, for instance, will result in throwing the center line of the drilled hole more than 0.001 inch out of line with the center of the work. For strictly interchangeable work, where the accurate location of a hole such as that indicated at *a* is required, the location of the V-block must be given careful consideration.

Dimensioning V-block Drawings

Drawings for V-blocks are often dimensioned incorrectly as shown at *A*, Fig. 2. It is impossible to obtain satisfactory results when this method of dimensioning is employed, especially if the center line of the work is required to be located a given distance above the table on which the V-block is to be placed. The view at *B* shows the proper method of dimensioning a drawing of a V-block required for accurate work. It will be noted that the diameter *e* of the work is given, and that the distance *f* from the base of the block to the center line of the work is also given. This method of dimensioning should invariably be employed if the center of the work, when placed in the V-block, is required to have a definite position relative to some other point.

Grinding V-blocks

The grinding of the sides or angles of a V-block intended for production work is one of the most common mistakes made in the tool-room. At *A*, Fig. 3, is shown a V-block which is ground on the sides *b* and *c*, and provided with a groove *d* to facilitate the grinding and machining operations. A V-block of this type, if intended for production work, is not practical, as it is evident that a round piece of work would bear only on two points. As these bearing points wear very rapidly, the result would be that of constantly lessening the distance between the center of the work and the base or bottom of the block. If the work is not required to be very accurate, this slight wear can, of course, be ignored. At *B* is shown a V-block of similar design to that shown at *A*, but which is lapped at the locating points *f* and *g* instead of having ground sides. The lapping operation produces small lands at *f* and *g* which locate the work very accurately. It is obvious that the location of the work is as accurate with the block shown at *B* as with that shown at *A*, and that the increased bearing surface of the lapped block gives added assurance that it will maintain its accuracy much longer. In making drawings for V-blocks of this kind, the dimension *h* from the base to the center line of the work should be given. In machining the block, proper allowance should, of course, be made for lapping.

The deep relief or groove cut in V-blocks to facilitate machining often causes cracking as shown at *c*, Fig. 4, when the block is hardened. This is especially true of shallow V-blocks of the type shown at *A*. It is evident that the small amount of stock indicated by dimension *b*, together with the sharp corners at the bottom of the groove, make it difficult to harden the block properly without producing cracks. At *B* is shown a V-block in which the neck has been eliminated. It will be noted that the dimension at *e* is considerably increased in this case, which greatly lessens the danger of cracking when hardening. When this type of block is used for production work, it will be found advisable to employ the lapping method of finishing, as indicated at *B* in the illustration Fig. 3.

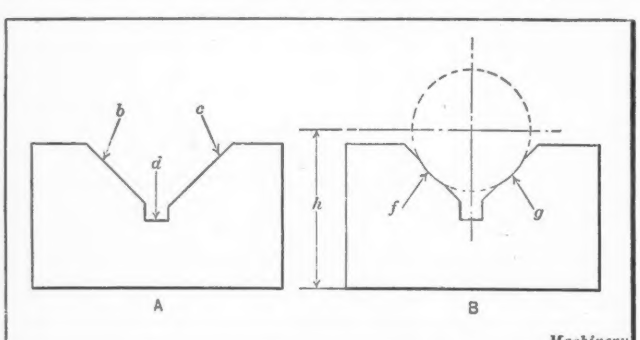


Fig. 3. Ground and Lapped V-blocks

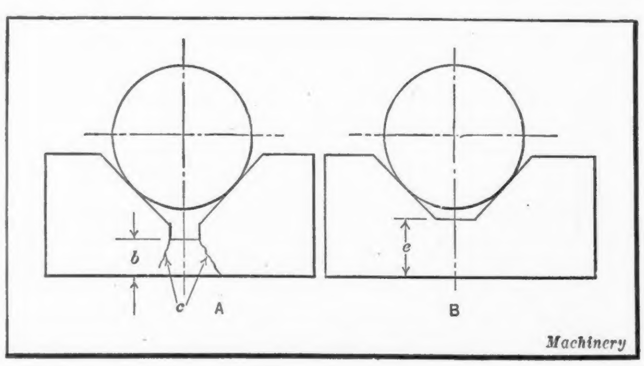


Fig. 4. Shallow V-block Design

INDUSTRIAL CONDITIONS IN FRANCE

By MACHINERY'S Special Correspondent

Paris, March 13

French business men are watching with interest the rising value of the franc in relation to the dollar and pound sterling, because it is felt that any considerable increase in the value of the franc would cause a grave reaction on the economic situation. It would be necessary to reduce salaries proportionately, and, furthermore, stocks would depreciate in value. A reduction of ½ per cent on the tax payable on interest received from state bonds is seriously considered. Such a measure would have an excellent effect on trade.

Business in General

There has been no marked improvement in business conditions taken as a whole, although there is considerable activity in the automobile field. The Renault company has taken on 5000 workmen during the last few months. Besides automobiles, this concern also manufactures locomotive parts, Diesel engines, and a few machine tools. The machine tool field continues to be very quiet. The output of the coal mines in the Bassin du Nord region increases daily, and the deficiency caused by Germany's defaulting in the delivery of coke has been made up. The production in the devastated regions during 1921 was about 5,365,000 tons—a considerable increase over the figure for 1920 of 2,450,000 tons. In 1913 the production was 18,660,000 tons.

Effect of New Customs on German Machine Tools

The heavy duties imposed by France on German machine tools lead American and British dealers to look forward to increased sales. The increase in the value of the franc also tends toward that end. The duties imposed on German machine tools of various weights are as follows, considering the value of the franc as 9 cents:

Weight	Francs per 100 Kilograms	Dollars per 100 Pounds
Over 25,000 kilograms (about 27.5 tons)	132	5.40
From 5000 to 25,000 kilograms (5.5 to 27.5 tons)	158.4	6.50
From 1000 to 5000 kilograms (1.1 to 5.5 tons)	211.2	8.60
From 250 to 1000 kilograms (550 pds. to 1.1 tons)	316.8	12.90
250 kilograms and under (550 pounds)	660	26.90

The duties imposed on other foreign machine tools are only one-fourth those levied against German products.

Taking a double-head Lincoln-type milling machine of German make, as an example, the method of calculating the final price would be as follows: Price quoted, 4125 francs; customs duty, 2217 francs; importation tax, 45 francs; and customs clearance fee, 26 francs, making a total of 6413 francs (about $580).

According to quotations, the prices of other standard German machine tools, considering the mark worth 5.5 centimes, are approximately as follows: A continuous vertical milling machine weighing 4000 kilograms (about 4.4 tons) costs 22,450 francs (about $2000) or about 5.6 francs per kilogram; a vertical boring mill weighing 8000 kilograms (about 8.8 tons) costs 37,900 francs (about $3400) or 4.73 francs per kilogram; a Landis-type threading machine weighing 1050 kilograms (about 2300 pounds) costs 6090 francs ($550) or 5.8 francs per kilogram; and a lathe weighing 4300 kilograms (4.75 tons) costs about 21,700 francs ($1950) or about 5.05 francs per kilogram.

Prices of American Machine Tools

The prices of high-grade American machines, based on the weight, range between 8 and 10 francs per kilogram (32.6 to 40.8 cents per pound). A vertical milling machine of well-known American make, weighing 1300 kilograms (2870 pounds), is offered for sale at 13,000 francs (about $1170) which amounts to 10 francs per kilogram. A universal milling machine weighing 3200 kilograms (3.5 tons) sells for 31,360 francs ($2820) or 9.8 francs per kilogram. Taking price and quality into consideration, one of the large French dealers handling German and American machines believes that there is little difference from a sales standpoint between the machines received from the two countries. French buyers, however, are still tempted by the lower price of the German machines, this being partly due to the effective work of German salesmen. The price of French machine tools varies from 8 to 10 francs per kilogram, which is the same as for American machines.

* * *

MACHINE TOOL INDUSTRY IN SWEDEN

The building of machine tools in Sweden began to be of some importance between the years 1840 and 1850. In the early development of the industry each machine shop made all the machine tools required in the manufacture of its particular product, but after a few years a number of shops began to specialize on certain machines and build them as a commercial product; and machine tools eventually became their principal line.

As far as quantity and variety are concerned, the production of machine tools in Sweden cannot compete with that of the United States, Germany, or England, all of which have enormous domestic markets. The Swedish manufacturers of machine tools have based their production on the home consumption and have not paid much attention to the export market. The natural result is that the manufacture of machine tools in Sweden embraces only the types and sizes which are most in demand by Swedish industrial enterprises. They are those general utility machines which can be produced in considerable quantities even though the area of the market is limited. As a general rule it may be stated that heavy and expensive machines and special-purpose machines of the type of which only one or a few are required in any one factory, are not manufactured in Sweden.

Lathe Production and the Market for Lathes

Lathes form the major part of the machine tools manufactured in Sweden. In 1914, prior to the war, there were at least three Swedish concerns of considerable size engaged in the manufacture of modern types of lathes—the Köping, Munktell, and Lidköping Works. In fact, the Swedish production of standard types of lathes had at that time grown to such proportions as to meet the domestic demand. An export market had also been obtained in the neighboring Scandinavian countries, as well as in Finland, Russia, and some of the other smaller countries. At the Baltic exhibition in Malmö in 1914 the design and quality of workmanship of the Swedish lathes aroused favorable comment by German engineers, and by the German technical press.

The war brought on an enormous demand for lathes and some of the European belligerent countries were unable to supply the manufacturers of war material with the necessary quantity of these machines. This presented an opening for the Swedish machine tool builders, which they were not slow to take advantage of. Not only did the previously established machine tool manufacturers engage in supplying this demand, but many other manufacturers started building lathes, with the result that a large export trade with Russia, England, France, Germany, and Austria was developed. Although most of this export trade was of a temporary nature, it resulted in the older establishments enlarging their plants and improving their methods so that they are now better prepared to compete with those of foreign make than before.

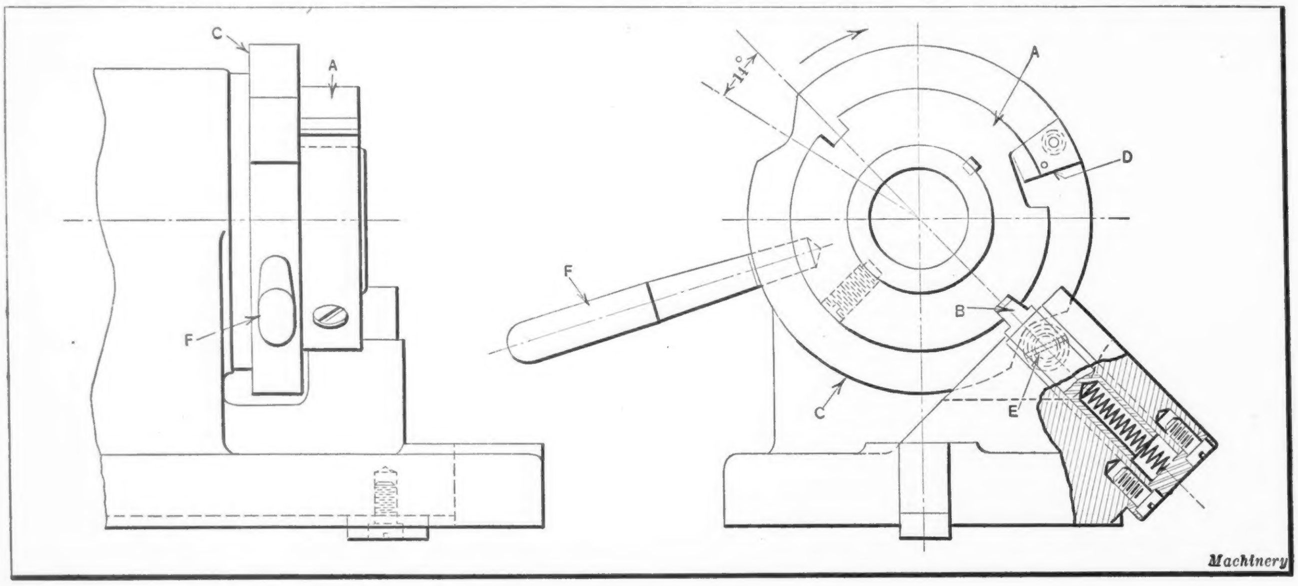
Machine Tools other than Lathes

Planers and shapers of standard types are manufactured in Sweden in sufficient numbers to satisfy the domestic demands. Before the war there had been some export trade developed with the neighboring Scandinavian countries. Power presses, drop-hammers, and forging machines of different types are also among the machines produced by the oldest of Swedish machine tool manufacturers. Very few machines of these classes are imported into Sweden. Other kinds of machine tools manufactured in Sweden are drilling machines, milling machines, and boring machines.

INDEXING MECHANISM WITH AUTOMATIC PAWL RELEASE

Many designs of jigs and fixtures require an indexing movement for locating work in different positions relative to the cutting tool. It is common practice to so arrange the indexing device that the locating plunger or pawl must be released with one hand while the work-spindle is turned with the other. The indexing mechanism shown in the accompanying illustration is so arranged that the locating pawl is automatically released and the work-spindle can be rotated from one position to the other by means of a single hand-lever *F*.

This indexing mechanism is arranged for holding the work-spindle in two positions, 180 degrees apart, as governed by the notched locating plate *A*, which is engaged by plunger *B*, the latter being pressed inward against the plate by a spring. Adjacent to the notched locating disk there is a pawl-releasing plate *C*. This plate has two curved recesses, and one of these must be opposite roller *E* on the pawl whenever the latter is in engagement with the locating plate.



Indexing Mechanism with Automatic Pawl Release

When plate *C* is turned clockwise, as indicated by the arrow, roller *E* rides up on the periphery of *C*, thus forcing the pawl back out of engagement with the locating notch. As the work-spindle cannot rotate until the pawl is withdrawn, plate *C* is permitted to turn independently about 14 degrees, or far enough to allow roller *E* to be forced backward out of the locating plate.

This independent movement of plate *C* occurs while dog *D* is moving across to the opposite side of a slot formed in plate *A*. The movement of disk *C* relative to the work-spindle also causes the roller recess on the other side to move around 14 degrees, or until it is in alignment with the locating slot on that side; consequently, the pawl is free to engage this slot after the work-spindle has been turned one-half revolution. This indexing mechanism is used by the designing department of the Pratt & Whitney Co., Hartford, Conn., whenever such a device is required for jig and fixture work.

* * *

An international exhibition of foundry equipment and materials will be held in Birmingham, England, June 15 to 24 in connection with the annual convention of the Institution of British Foundrymen. The exhibits will be shown in Bingley Hall, and will embrace every phase of foundry work.

TEN YEARS' EXPORTS OF MACHINE TOOLS TO GREAT BRITAIN

In 1912 Great Britain imported $2,678,995 worth of machine tools and metal-working machinery from the United States; by 1914 her imports of American machines had increased to $3,174,333. Owing to the war demands, the British market rose abnormally during the period 1915 to 1918, reaching a maximum in 1916 when $20,434,934 worth of American machines were imported. This represented an advance of nearly 600 per cent over the 1914 market. Since the war there has been a rapid decline from this high level. During the last two years there has been a growing tendency for Great Britain to increase her exports of machine tools and metal-working machinery, with a corresponding decrease in imports of these machines, the imports of American machine tools and metal-working machinery for 1921 amounting to only $2,698,321.

The statistics show that in 1912 Great Britain consumed 22 per cent, in 1913, 21 per cent, and in 1914, nearly 23 per cent of the total American exports of machine tools and metal-working machinery. Although in 1921 Great Britain consumed only 14 per cent of the total exports, this 14 per cent represented, in dollars, slightly more than the 22 per cent taken in 1912, as the amounts in the table show.

Detailed statistics are not available for the years previous to 1918, but it is interesting to note from the table the changing demands for various kinds of machines during the last four years. In 1918, 1919, and 1920 American machine tools were in much greater demand in Great Britain than other metal-working machinery, but during 1921 the market for the latter rose slightly above the demand for machine tools.

VALUE OF MACHINE TOOLS AND METAL-WORKING MACHINERY EXPORTED TO GREAT BRITAIN, 1912-1921

Year*	Lathes	Sharpening and Grinding Machines	Other Machine Tools	Total of Machine Tools	All Other Metal-working Machinery	Total of Machine Tools and Metal-working Machinery
1912	....	....	....	....	....	$2,678,995
1913	....	....	....	....	....	3,411,143
1914	....	....	....	....	....	3,174,333
1915	....	....	....	....	....	12,292,312
1916	....	....	....	....	....	20,434,934
1917	....	....	....	....	....	16,296,923
1918	$5,122,556	$2,095,703	$4,506,135	$11,724,394	$6,671,134	18,395,528
1919	2,895,800	1,620,892	4,385,274	8,901,966	6,307,914	15,209,880
1920	1,772,918	1,202,833	3,275,285	6,251,036	4,748,061	10,999,097
1921	134,630	177,497	754,967	1,067,094	1,631,227	2,698,321

Machinery

*Amounts given are for fiscal years up to and including 1918 and for calendar years thereafter.

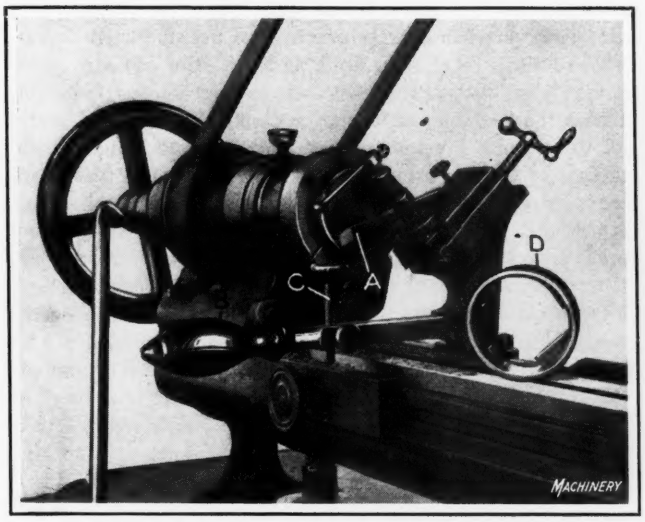


Fig. 1. Set-up employed for threading the Bezel Case of a Dial Gage on a Bench Lathe

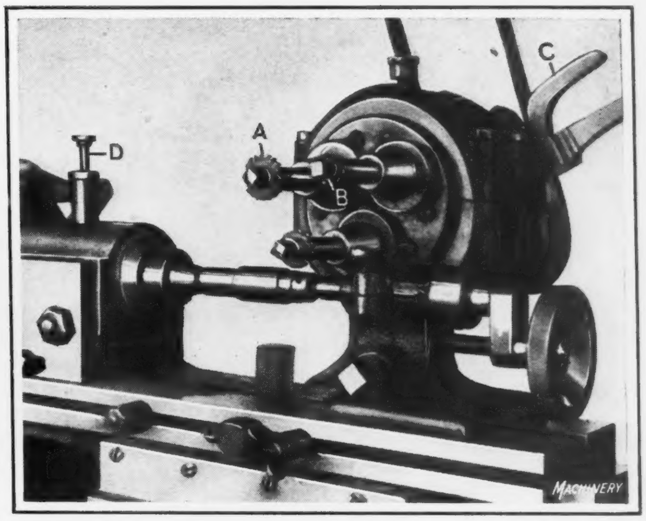


Fig. 2. Milling Machine with Special Cutter-head for machining Gage Train Wheels

Tooling Equipment and Methods Used in Making Dial Gages

Some Interesting Operations Performed in the Stickney & Randall Plant, Waltham, Mass.

By ROBERT MAWSON

THE thickness dial gage manufactured by Stickney & Randall consists of a stand, on the upright part of which there is fitted, by a tongue and groove construction, a vertical bearing for the stem of the table. The table and the stem are integral, and adjustment and location are obtained by means of adjusting screws. Fig. 3 shows the application of the gage for testing the location of a hole in the dial case. This case is fitted to the top part of the casting, which is machined to receive it, and through it extends the gaging spindle *A*, which is operated by the lever shown at the left side of the gage. The registry mechanism for the dial provides for obtaining readings in thousandths of an inch by means of the long hand, and in ten-thousandths of an inch by the short hand.

The first operation to which attention is directed is performed with the set-up shown in Fig. 1 and consists of threading the bezel case. This part is cast from a special hard composition and is held in the chuck of a Stark bench lathe. The threading tool *A* is fed to the correct depth by operating handle *B* which is carried by the lead-screw at the rear of the lathe. The proper depth of thread is obtained by the adjusting screw *C* which, after the adjustment has been obtained, can be locked in the correct position by means of the knurled screw on the side of the arm of the attachment. The case may be clearly seen at *D*, the casting being 2 inches in diameter and containing 32 threads per inch cut internally with the equipment shown.

Fig. 2 shows a Stark bench milling machine equipped for machining the steel train wheels of the dial gage. Twenty-five of these wheels, or gears, are placed on an arbor at a time and the outside diameter is machined to the correct measurement by cutter *A* carried on one of the three spindles of a special index milling head. The second spindle, which is the one shown in position for machining the wheels, is used to rough-cut the teeth, and the third spindle *B* performs the finishing operation on the teeth. In machining brass wheels spindle *B* is not required. For machining the outside of the wheels, both the cutter *A* and the arbor revolve, the speeds and feeds being so arranged that the spiral cut taken will reduce the diameters of the stack of blanks to the size required. After the head has been indexed by operating the lever *C*, the arbor is held stationary by pin *D* in the index-head during the cutting of the teeth. The blanks are machined with 100 teeth and the index-head is operated by a gear and index-pawl at the extreme end of the head.

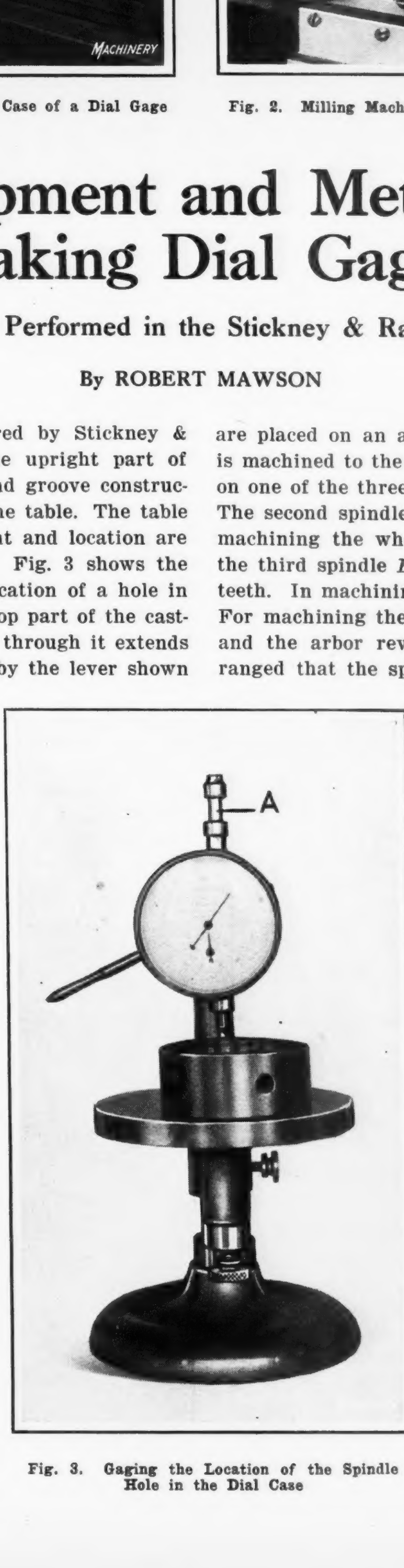


Fig. 3. Gaging the Location of the Spindle Hole in the Dial Case

Use of Jeweling Caliper to Obtain Force Fit

A number of small pinions and the staffs or studs on which they are assembled are shown on the ways of the bench lathe in Fig. 4. It is important that the staffs and pinions of all the gages have the same degree of fit, and to obtain this result a jeweling caliper, commonly used in the watchmaking industry, is employed. The staffs are made on an automatic and there is some slight variation in their diameters, so that some method must be employed to compensate for this variation. The pinion is bored out with the tool carried on the end of the push-spindle *A*. The radial adjustment of this tool to provide the necessary degree of fit is obtained by placing the staff between the jaws of the caliper as shown at *B* and using

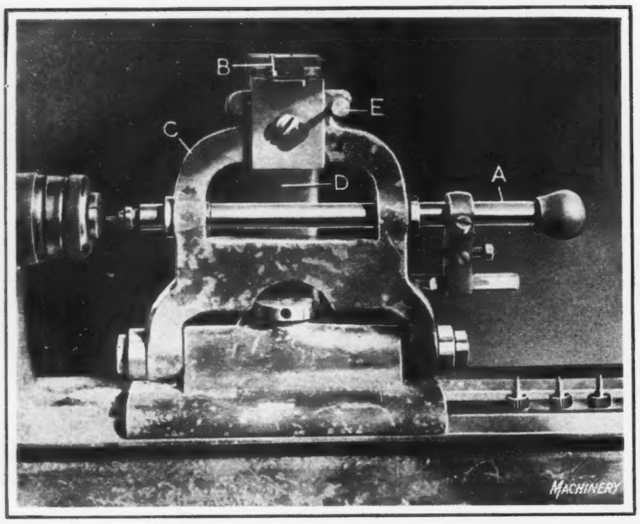


Fig. 4. Jeweling Caliper for obtaining Force Fit between the Pinions and the Staffs

it to gage the amount of metal removed in the boring operation on the pinion, which is later to be assembled on the staff. The pinion is chucked from the outside diameter as shown, and the arm *C*, which fulcrums on a shaft at the base of the tool, is swung forward until its jaw grips the staff. The stationary jaw (which does not show clearly in the illustration) is carried on the column *D*. If it is desired to bore the pinions with a larger hole than is required for a force fit, the necessary adjustment is obtained by the adjusting screw *E*, the point of which is brought up against an ear on the stationary column *D*.

After the arm which carries the spindle has been properly located, the operator pushes the boring tool into the revolv-

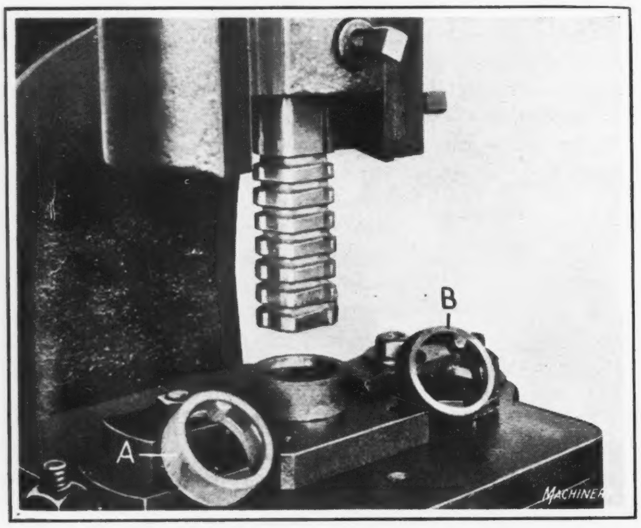


Fig. 5. Broaching the Inside of the Dial Case

ing pinion, the spindle being provided with long bearings to maintain the correct alignment. By this method the pinion staff hole is bored slightly smaller than the outside diameter of the shaft or just enough to allow a good drive fit. After the gage has once been set, it requires no readjustment until all the parts have been completed. The length of travel of the spindle is governed by a stop on the spindle near the rear bearing.

Operations on the Dial Case

The broaching of the inside of the case is shown in Fig. 5. This work is done on a screw press—a bench tool commonly used in watchmaking and similar work. The casting is placed on the table of the machine and is located in relation to the cutting edges of the broach by a short pilot. The pilot and the broach are of special shape as required by the irregular contour machined. A casting before and after broaching is shown at *A* and *B*, respectively, and another case partly machined is shown in position under the broach.

The drilling of the bushing holes in the cases is shown in Fig. 6. The bushings that are assembled in these holes furnish the bearings for the gaging spindle or stem *A*, Fig. 3, and these holes must be drilled accurately to bring the center line of the gaging spindle parallel with the face of the case. Previous to this operation the outside of the case is turned and ground to size; it is located in the jig shown by means of adjustable V-blocks and stop-pins at the rear fitting against the lugs on the inside of the case. The V-blocks slide in the jig and may be clamped in the desired position by machine screws. The holes to be drilled are not radial, and so in order to start the drill correctly and prevent it from pushing over to one side when starting, the spotting tool shown at the left is first employed. After a hole has been drilled through from one side, the spotting

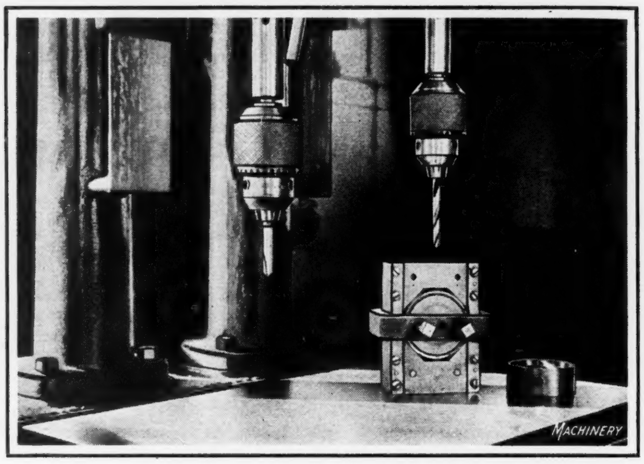


Fig. 6. Drilling the Holes through which the Gage Spindle operates

and drilling operation is repeated on the opposite side by simply reversing the position of the jig on the table.

For inspecting the parallelism of the spindle hole in the case and for checking its location relative to the face, the work is placed on the table of a regular thickness dial gage, as shown in Fig. 3, and the spindle *A* provided with a wide foot to extend into the hole and register its location from the surface of the table. By repeating the operation on the opposite side of the case the parallelism can also be checked. It is important to hold this degree of parallelism to the closest possible limits so that the gage stem will slide smoothly in its bearings.

Drilling Pillar Plates for Train Wheels

A bench type of multiple drilling machine which is used for drilling the train wheel plates of the dial gage is illustrated in Fig. 7. The plates, which are simply plain circular

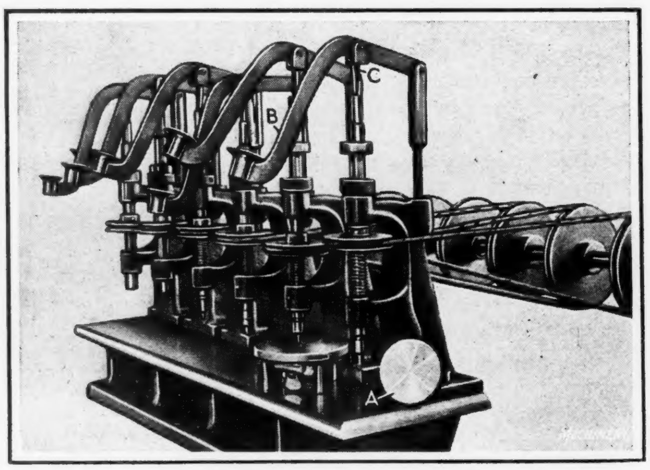


Fig. 7. Bench Type Multiple Drilling Machine on which the Pillar Plates are drilled

disks shown at *A*, are located in a four-legged drill jig, being clamped on the under side by a circular cover-plate which fits the outside of the work. To load this fixture, it is simply necessary to invert it, slip the work under the clamping straps, and tighten the wing-nuts which bind the clamping dogs firmly in place.

The drilling machine has six spindles, driven by twisted rawhide belts from a countershaft at the rear of the machine. The countershaft is adjustably supported so that it may be raised or lowered when changing the tension on the belt. Hand feed is used, the operator simply forcing down lever *B* which hinges in the yoke end of connection *C*, the opposite end of this connection being fitted to the end of the spindle by a loose ball and socket joint. When lever *B* is released

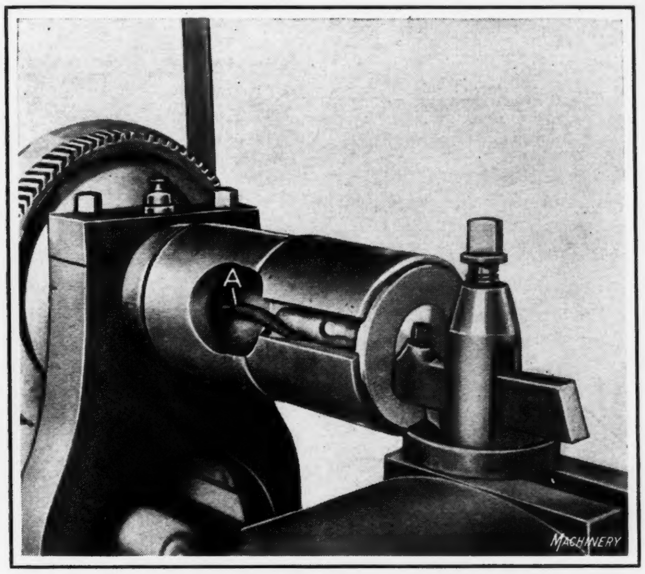


Fig. 8. Equipment used in facing the Base of the Gage Stand

at the completion of the drilling operation, the coil spring interposed between the spindle driving pulley and the lower bearing, returns the spindle and drill to the upper position. Multiple-spindle drilling machines of the bench type, such as this one, are extensively used in the manufacture of various parts of dial gages.

Machining the Gage Stand

The first operation performed in machining the gage stand —facing the base—is shown in Fig. 8. The design of the piece being machined is shown at *A* in Fig. 10. It will be seen that there is a pad on the part of this stand to which the bearing for the table stem is fitted. In facing the base,

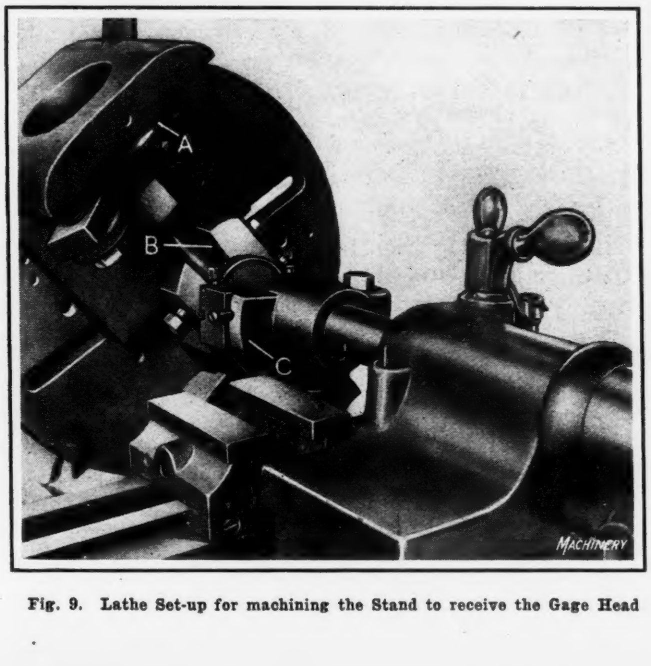


Fig. 9. Lathe Set-up for machining the Stand to receive the Gage Head

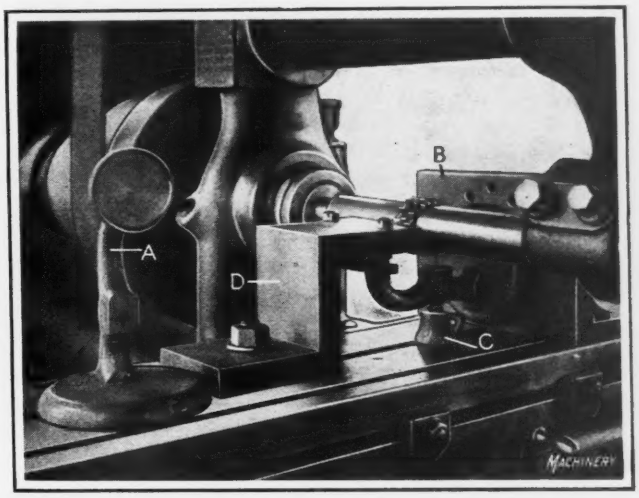


Fig. 10. Milling the Pad to which the Table Stem Bearing is attached

the casting is placed in a cylindrical fixture, seated on the end, as shown in Fig. 8, the upright part extending in and being drawn firmly into position by a hook *A*, which engages the casting back of the dial case cup section; this hook is operated similarly to a draw-in chuck. The nut is screwed up by the operator until the casting is located against the face of the fixture, after which the facing operation is performed in the usual manner.

The stand is then machined to fit the gage head, in the fixture shown in Fig. 9, which is attached to the faceplate of a lathe. The base *A* of the casting is located against a foot on the angle-plate fixture and clamped by means of straps. A slot *B* locates the work properly relative to the center of rotation and also drives it through two screws

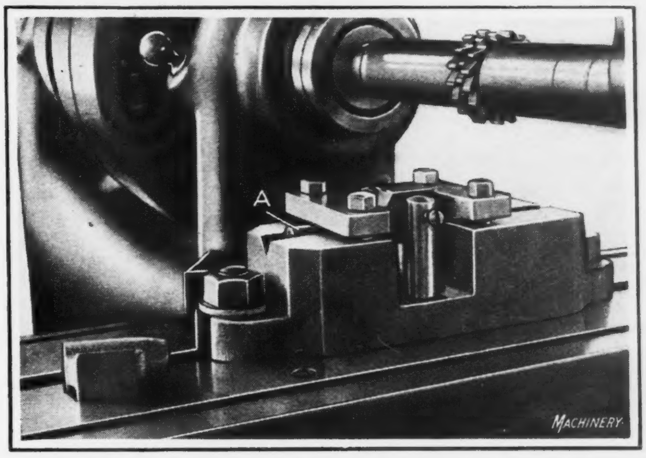


Fig. 11. Equipment used for milling the Surfaces by which the Table Stem Bearing is fitted to the Stand

which bind the work in place. The operation consists of turning the outside and inside surfaces of the circular wall within which the dial indicating mechanism is contained, and the work is performed with a special tool-head *C* in which both the tools required for the operation are carried.

In machining the pad to which the table stem bearing is attached, care must be taken to machine this surface so that when the table is assembled in the bearing, the center line of the stem will be normal to the base of the gage. The pad is machined with a tongue, using a gang of three plain milling cutters. A simple angle-plate fixture *B*, Fig. 10, is employed and a screw-jack *C* for supporting the piece during the operation and preventing distortion caused by the thrust of the cutters. The gage-head end of the casting is clamped to the double angle-plate *D*, both this plate and the one against which the base is attached being located on the machine table by tongues engaging the central table slot. By this set-up the machined surfaces are maintained in correct relationship to each other.

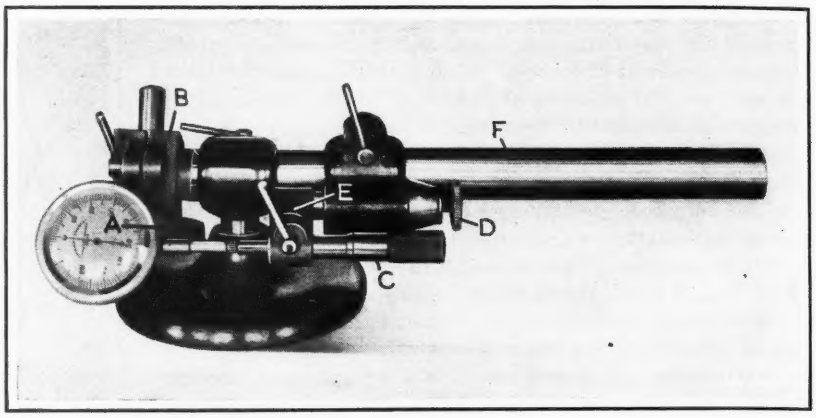


Fig. 13. Equipment used in the Final Inspection of the Indicator

Other Equipment Used in the Manufacture of the Gage

Equal care must be taken when machining the fit for the table stem bearing casting. This casting is shown lying on the table of a milling machine in Fig. 11 before being machined, and located in the fixture after the operation has been completed. Before the work comes to this machine, the stem hole is drilled and reamed in a lathe, no special equipment being employed. The casting is then placed on an arbor *A* which fits the reamed hole and extends beyond at each end, being located on the fixture by a V-groove in which the projecting ends of the arbor rest. The gap in the fixture allows the casting sufficient clearance space, and the chips from the cutters accumulate in this cut-out section instead of in the V-groove. The casting is located in an upright position between two adjusting screws carried in posts at opposite sides of the fixture, and is secured to the fixture by ordinary spring-supported straps. The method of locating and clamping the work should be apparent from the illustration. A gang of three milling cutters is employed to mill the groove corresponding to the tongue on the pad of the gage stand, which was milled with the equipment illustrated in Fig. 10.

Fig. 12 shows the grinding operation performed on the face of the gage table *A*. The turned stem of the casting is held in the fixture *B* by a clamp bolt which tightens the split bearing in which the stem fits. A very simple type of workhead is employed, which is mounted rigidly on the table of the machine and driven by a belt in the regular way. After the work has been secured in the fixture, the table of the machine is fed in and then traversed back and forth across the grinding wheel until the desired results are obtained. This gives the surface of the gage table a smooth finish and assures that it will be exactly at 90 degrees with the center line of the stem and consequently parallel with the base of the stand.

The final inspection of the indicator is made with the device illustrated in Fig. 13. The finished indicator is attached to a disk *A* which has a stem by means of which the disk is locked and adjusted radially in a split bearing *B* in the head of the shaft *F*. This allows for inspecting indicators of various sizes. It will be noticed that the indicator is not shown in the position that it would occupy if it were actually attached to the disk, but is tipped so that the readings on both the indicator and the micrometer thimble *C* may be observed. The micrometer head may be located on shaft *F* by means of a pin lever which binds the split bearing where desired. Final longitudinal adjustments of the micrometer spindle are accomplished by the knurled screw *D*, and the spindle itself may be removed from its bearing for convenience in changing the arm *E* in which it is carried. With the instrument located so that the indicator spindle is in alignment with the micrometer spindle, the micrometer spindle is brought into contact with the end of the indicator spindle, both readings registering zero. As previously mentioned the adjusting screw *D* is used to bring the micrometer reading to the exact zero mark on the micrometer thimble. If the indicator is correct, the readings on the micrometer head and on the gage dial will correspond as the micrometer thimble is turned. Shaft *F* carrying the entire set-up may be revolved in its bearing and located to obtain the best lighting effect for the inspector.

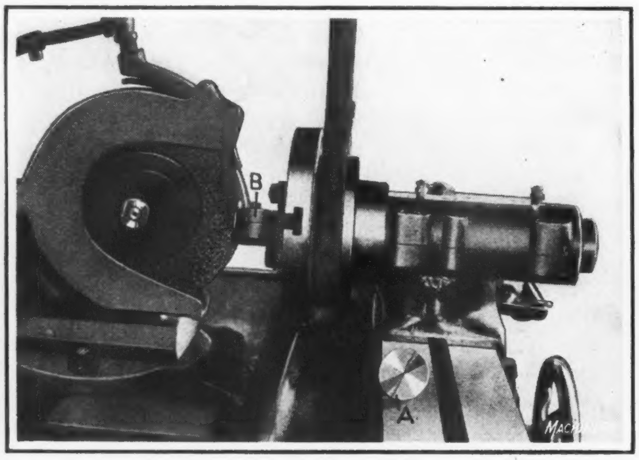


Fig. 12. Grinding the Face of the Gage Table

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STANDARDIZATION ACTIVITIES

The American Engineering Standards Committee has just completed arrangements by which cooperation with the standardizing bodies in other countries will be made more effective. In order that all standards shall be available to the industries of the various countries, it is planned that each national body will sell the approved standards of the other bodies. The American Engineering Standards Committee, 29 W. 39th St., New York City, has available the publications of the standardizing bodies in Austria, Belgium, Canada, France, Germany, Great Britain, Holland, Sweden, and Switzerland.

The work of standardization in the iron and steel field in the United States has been furthered by the addition of two new member bodies—the American Railway Association (Engineering Division) and the Association of American Steel Manufacturers—to the American Engineering Standards Committee. The Association of American Steel Manufacturers is an organization of forty iron and steel manufacturing companies. Its activities are limited to the standardization of rolling mill practices, and to the standardization and inspection of iron and steel products. The American Railway Association, which represents practically all the steam railways of the country, has four great technical branches, each having its own secretary, the Engineering and the Mechanical Divisions, the Signal, and the Telephone and Telegraph Sections.

* * *

The feasibility of arc-welding alloy steels has been demonstrated by the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. With adequate mechanical treatment and heat-treatment, tensile strengths of 130,000 pounds per square inch have been obtained in the weld. The possibility of forging arc-deposited metal has been clearly demonstrated, as well as the resistance of the forged metal to fatigue stresses; this widens the field of application of the process. Progress has also been made by the company in percussive welding. It has been shown that materials can be quickly and efficiently welded by this method, which cannot be so united by any other known method, and uniform welds can be produced.

REFITTING BEARINGS IN AUTOMOBILE CRANKCASES

A specially designed boring-bar and fixture is used in the shop of the Detroit Cadillac Motor Car Corporation, New York City, for line-boring the bearings of automobile crankshafts. This equipment, which was made especially for Cadillac automobile repair work, has been the means of greatly increasing the accuracy of the job and decreasing the time required to perform it.

When the crankshaft journals of a Cadillac motor have been found to be worn so far under size and out of round that it is impracticable to fit bearings to them, the crankshaft is removed from the case and the three journals are ground to a uniform diameter, depending on the condition of the crankpins. In fitting new bearings to this reground shaft by the old method, a large amount of hand scraping and fitting was required. By the new method, the cases are first fitted with three under-sized bearings supplied by the factory, and these are placed in position in the crankcase after the shaft has been reground, and are then line-bored. A view showing the top of the crankcase with the boring-bar and fixture in place is shown in Fig. 1, and Fig. 2 shows the underneath side of the fixture.

This boring-tool consists of a single bar in which three cutters are carried, the cutters being set radially 120 degrees apart. The cutters operate simultaneously, one on each bearing. A rigid fixture is provided for supporting the bar, as shown in Fig. 1. This consists of a heavy steel bar *A*, to which two heavy double-armed castings are fitted, the extending ends of which carry accurately ground pads, which are designed to rest accurately on the crankcase cylinder block faces. As a secondary means of location, a locating pilot *B* is used at the front end of the fixture which is inserted into the oil-pump drive shaft bushing on the casting.

Fig. 2 shows the method of supporting and clamping the case while the bearings are being bored, as well as the method by which the bar is located and the feeding arrangement. Here the feed-nut *C* which is hinged over the threaded boring-bar is shown open for the purpose of illustrating how the nut is closed and clamped on the bar. This nut is carried by an arm *D*, Fig. 1, which may be swung into a vertical position when the tool is not in use; then the hinged member of the nut is closed around the bar as shown. The threaded part of the boring-bar, which constitutes the feed-screw, is of very fine pitch, and the cutters are fed through the bearing by turning the handle at the end of the bar.

The three cutters on the boring-bar are set to bore out under-sized bearings to a diameter 0.002 inch greater than that of the ground crankshaft journals. Great care has been exercised in the manufacture of this boring-bar, and it is stated that even with the bar pulled out so that no support is afforded at its further end, the end will not run out more than 0.0005 inch. The operation of fitting these main bearings, including setting up the bar and its cutters, takes approximately one hour. The former method of fitting these bearings to a reground shaft took about ten hours and could not be done even then with the same degree of accuracy that is possible with this tool.

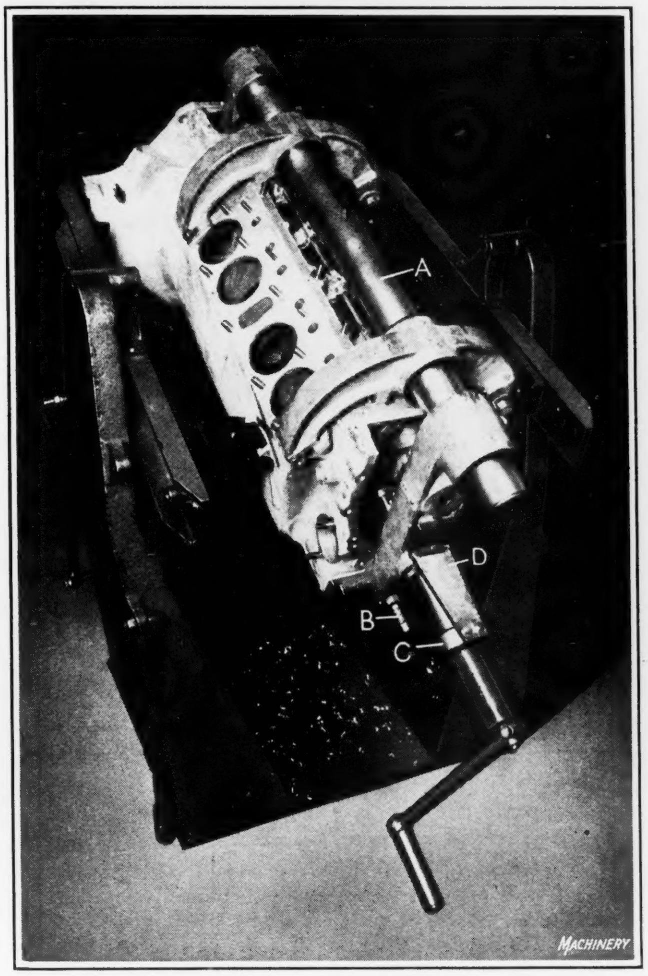

Fig. 1. Boring-bar and Fixture used for refitting Main Bearings of Crankcases

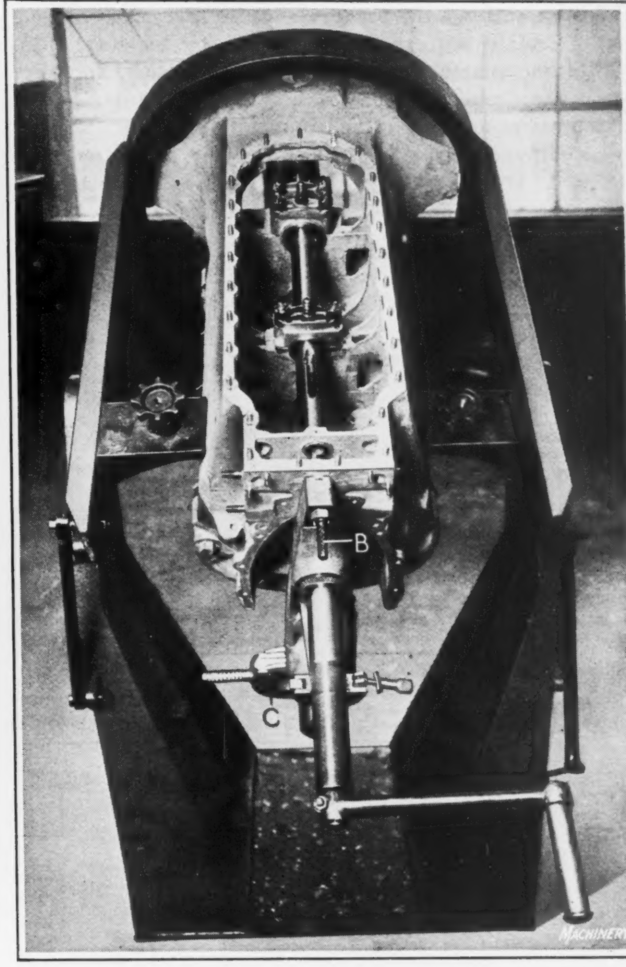

Fig. 2. View of Reverse Side of Crankcase, showing Interior and Bar in Place

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NATIONAL FOREIGN TRADE CONVENTION

The ninth national foreign trade convention will be held in Philadelphia May 10 to 12. Some of the important topics to be considered at this meeting are the following: Financing foreign trade; the merchant marine; foreign investment; taxation; education for foreign trade; banking facilities; sales promotion; foreign competition; foreign credits; combination for export; foreign advertising; and the stimulation of foreign trade.

Organization of a Large Tool Division

Duties of the Various Members and Units of an Organization Responsible for the Development of Quantity Production Tools

By H. P. LOSELY, Industrial Engineer, Detroit, Mich.

THE manufacture of a new product in a plant in large quantities and with a sufficiently low cost to compete with other manufacturers of the same product necessitates the making of special tools, jigs, and fixtures, the number of which depends, of course, upon the number of component parts of the product and the operations on each part. In addition to this, although special tools are being used in the making of an established product, increased competition occasionally necessitates the redesigning of tooling equipment to permit the product to be more economically or satisfactorily made. The supplying of a large plant with tools of this class obviously involves a tremendous amount of work, and tool superintendents are frequently unable to handle it efficiently, due mainly, to the system under which the tool division operates. In the following, a description is presented of a tool division organization which is based on the experiences of four manufacturing concerns, three of which developed tools for a new product, while the fourth constantly makes tools to suit contract orders.

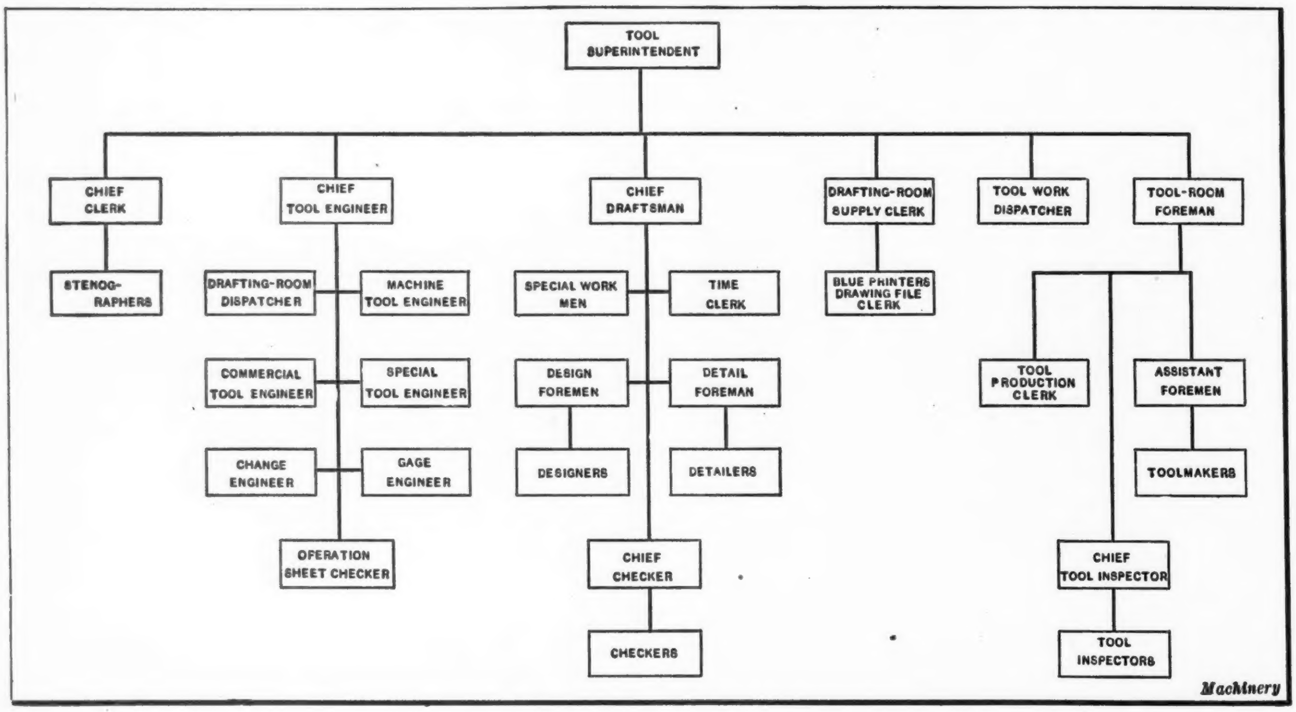


Fig. 1. Organization Chart for a Large Tool Division

Graphic Representation of Tool Division

A chart showing the arrangement of the members and units of the tool division to be described is illustrated in Fig. 1. In this organization it is intended that between one and two hundred men are to be employed on the activities covered; with a smaller organization, some of the functions assigned to several men should be combined and assigned to one. Objections may be raised that there are too many bosses and too much overhead with this scheme. The fact is that in cases where the design foremen attend to all the functions here assigned to separate men, they cannot supervise many designers without neglecting them and often making them wait for work. This causes a waste of time more costly than the employment of a few specialized men to line up all the details of operation. Above all, the lack of centralized responsibility for each division of the work is certain to cause a lack of coordination, which requires a great deal of trouble to straighten out, or if not discovered, results in inefficient plant operation—for instance, excessive or insufficient equipment may be used, or work may not be assigned to the most suitable department.

The main burden of preparatory work falls on the chief tool engineer and his assistants, and their duties will be detailed at length. If their work is properly done and the drafting-room is well directed, the tool-room will get correct orders in the proper sequence. Furthermore, orders will be so distributed that the tool-room can meet the required deliveries. In adapting this plan to the needs of any particular plant, the chief point to bear in mind is that it is only a means of supplying the manufacturing departments with real tool service, that is, supplying them with the right tools at the right time. The duties of the men and units connected with the actual making of tools will not be described, because they will be evident from the titles.

Functions of the Tool Superintendent

The tool division is responsible for all activities relative to a tool up to the delivery of the inspected tool to the production department. This centralizes final responsibility for tools in the tool superintendent, and it is part of his problem to maintain harmony between the tool designing and tool making sections of the division as well as among

their individual members. It cannot be too strongly emphasized that the tool superintendent should be a broad-gage executive. It is an old rule that an executive must be thoroughly acquainted with the technical part of his work, but still more he must be able to handle his men, consider the needs of his co-executives, and so dispose his forces as to get maximum results from minimum efforts. The tool superintendent then, must be thoroughly familiar with general machine shop practice, and know what can and what cannot be done in the way of machining and processing, but his main duties are to coordinate the activities of his department and foresee the needs of other departments affected by his work. His problem is not one of ordering new equipment and designing tools, but is essentially determining in which direction he can most economically provide good tool service.

If a million dollar plant lies idle while waiting for the completion of tools when there are orders on hand which should be yielding a profit of $1000 a day, it is the duty of the tool superintendent to plan so as to cut down the idle time to a minimum, balancing the extra expense of overtime work against the reduction of loss on idle time. If deliveries of products are being retarded because one or two parts cannot be manufactured fast enough, the tool superintendent should see that he is properly informed, then determine whether extra tools are needed, and, if so, what would be a reasonable amount of money to spend on them. While such problems in their origin may be the concern of the production manager, their final solution devolves upon the tool superintendent, and the more his viewpoint is that of the broad business man rather than a purely technical one, the better will be his decisions. It is for this reason that, in the organization outlined, all technical duties are delegated to subordinates.

At the beginning of any tooling process, the tool superintendent should spend enough time on his organization and system to have it well lined up. A feverish start with the idea of turning out a great number of drawings and orders in a short time usually proves costly. At the same time forethought for the continuity of the personnel is necessary; to have key men leave the organization when a job is half complete may prove very disconcerting. It should be a point of honor with the key men not to leave work in an unfinished condition, and there should be a distinct understanding to that effect. If a bonus can be arranged for completion of a job within a definite time, it will be an additional advantage. Just how far to go with such a bonus system, of course, depends upon circumstances.

One of the first things to do on a job is to get an estimate of the amount of work to be done. The nature of the work precludes obtaining an accurate estimate; nevertheless past experience should be a good guide. For instance, the tooling of a complete high-class automobile involves designing some 10,000 special tools at an average of 30 hours drafting work, or a total of 300,000 hours. If an analysis of this description is made at the outset, the most economical size of tool division can be rapidly decided upon, and a plan mapped out for the distribution of work. In determining the outline of this plan, consultation with the financial, sales, and production departments is necessary, and as soon as the organization is settled upon, the tool superintendent should exert every effort to insure the fulfillment of the schedules agreed upon.

PART NO.

(1) FILL IN ENGINEER'S INITIALS & DATE

(2) FILL IN DATE RELEASED BY ENGINEERING DIVISION

OP. SHEET CHKD.	SPEC. TOOLS ORDERED	COMM'L. TOOLS ORDERED	GAGES ORDERED
1	1	1	1

PART RELEASED	PART NAME	MATERIAL
2		

PART NO.	ENGINEER WORKING ON OPERATION SHEET

Machinery

Fig. 2. Card used for keeping Track of Jobs while making up the Operation Sheets

W & S#2 INV. NO. 212

PART-OPER.	MINUTES PER OPERATION	CUMULATIVE MINUTES
1025-25	55	55
1026-25	40	95
1182-12	85	180
1197-5	25	205
1328-32	40	245
1329-32	40	285
1424-10	115	400

Machinery

Fig. 3. Card used for keeping Record of Amount of Work assigned to a Machine

Duties of Chief Tool Engineer and Drafting-room Dispatcher

Chief Tool Engineer—The chief tool engineer determines the general lay-out of operations on a part, and is responsible for the correctness of all operation sheets, all designs issued for special tools, and the completeness of orders issued for commercial tools. In other words, he must see that everything issued by the office is technically correct. It is evident that the person holding this position must be a man with a good technical knowledge and wide experience. In an organization of any size, he will find it necessary to delegate a considerable portion of his work to assistants as outlined on the chart, and should, therefore, be a good leader. The position of chief tool engineer is second only in importance to that of tool superintendent, and no pains should be spared in getting it filled properly.

Drafting-room Dispatcher—The function of the drafting-room dispatcher is to so distribute work to the tool engineering and designing sections that tool orders, both special and commercial, are sent out in the best possible sequence. The main qualifications for this position are a knowledge of tools and tool design; an appreciation of the relative importance of parts, both as to the amount of preparatory work involved and whether or not the parts can be made with improvised tools in case of emergency; steady habits; an ability to systematize work; and persistence in following up orders.

Dispatching Work through the Engineering Section

In dispatching work through the tool engineering section, it is first necessary to consider whether any particular work needs urgent attention. For instance, the machine tool engineer may report a shortage of machines for a certain class of work. It might then be advisable to have the operation sheets made out for parts requiring the use of such machines, before dispatching anything else, in order that the machine tool engineer will have definite information on which to base requests for additional equipment. Of equal importance is the dispatching of complicated parts requiring many operations and expensive tooling. Whether work should be dispatched first to the machine tool engineer or to the special tool engineer depends upon the relative time necessary to get the machines or special tools. It is well to remember that when an operation sheet has once been made out by the tool engineers, several draftsmen can work simultaneously on the various tool designs and the making of tools can be distributed among different shops, so that a great deal can be accomplished in three months. On the other hand, if there is a shortage of equipment, and deliv-

10845 | PART NO | TOOL DESIGNING PROGRESS RECORD | 10845

TOOL NO	LOCATION		
3406	Jones	Brown	Green
3408	Jones	Brown	Green
3409	Jones		
3410	Smith	Black	Green
3412	Smith	Black	
3413	Smith		
3414	Smith		
3415	Roberts	Brown	
3416	Roberts		
3417	Roberts		
G-25	Jones	Brown	Green
G-26	Jones	Brown	Green

Machinery

Fig. 4. Tool Designing Progress Record

eries of new machines will take six months or more, it will be more important to find out exactly what additional equipment must be purchased so that it can be ordered in ample time.

The dispatcher must have a complete list of the parts for which tools are to be made, and this list must be kept up to date. This is taken care of by routing all engineering release notices of parts over the desk of the dispatcher, the latter marking the release date on the form shown in Fig. 2, which will be discussed later. Occasionally parts are provisionally released, in order to make preliminary studies of tooling. These notices follow the same route as regular release cards, but they are specially marked. In order that the dispatcher and tool engineers may have ready access to the drawings of parts, it is advisable to keep an open file of all part prints for the use of the chief tool engineer's staff.

It is assumed that there are at least fifty jobs being handled in the tool design department at a time. The best way of following up these jobs is to list them on visible index cards somewhat similar to the one illustrated in Fig. 2. These cards are used for keeping track of jobs while the operation sheets are being worked out. As the jobs are assigned to the various engineers, the cards are marked accordingly. It is thus possible to tell at a glance how the engineering stands. When making out the card, the dispatcher should look into the probabilities of the part, and estimate roughly how much and what class of tooling work there will be. He must keep in mind the two main factors—getting work out on time, and keeping everybody supplied with work—and dispatch accordingly.

Dispatching Work through the Designing Section

If a plant is doing contract work, to get effective results, it should have a manufacturing schedule, and this schedule, if made in detail, should specify the date of each operation on a part, and thus automatically determine the priority sequence of tool orders. The dispatcher must then make every effort to have tools out on time to enable the manufacturing department to keep up with the schedule. However, in the majority of cases, it is a question of either supplying tools to permit the quantity production of a new article or to change existing manufacturing methods, and in such instances the priority question becomes more difficult to solve. The usual procedure is for the production manager to decide which tools he wants first; unfortunately this method is often unsatisfactory, primarily because no comparison of various requirements is made, the requests being usually based on the vociferousness of the different foremen's claims, or on what the production manager happens to see.

One method having good features is to insist on an estimate of savings to be accomplished by the use of any new tools ordered, as against present tools or no special tools, in the case of new production. Where a tool in new production is absolutely necessary on account of interchangeability, it may be marked "must" on the request. It will then be evident to the dispatcher that a tool which will save $3 a day is more important than one which will save only $1. Tools marked "must" will, of course, have the preference, as they are absolutely necessary. If, in addition, an estimate is marked on the order of the amount of time required for the designing and making of the tool, the dispatcher will have a chance to dispatch work so that the tools will be finished about in the correct sequence.

In Fig. 4 is shown a visible index card for recording the progress of tool designing. All tools for each part are listed by number on this card as soon as the order is issued. As the work is given out, the name of the man or company receiving it is noted under "Location." When the design is approved, the first vertical line to the left of the tool number is drawn; when the detail drawings are completed, the second line is filled in, and when the drawings are all checked and sent to be blueprinted, the third and last line is filled in. A horizontal line is drawn under the vertical lines when all the tools required for the part have been listed. This line is necessary, because the individual tool numbers are not visible without withdrawing the card from the index. The file thus shows graphically, at a glance, how the work stands on any part. This card is filed in a horizontal position, rather than in the vertical position shown in the illustration.

Duties of the Tool Engineers and Operation Sheet Checker

Machine Tool Engineer—The function of the machine tool engineer is to determine on which machine any given job shall be done. In doing this he must consider the following factors: The most suitable machine; other demands for the same machine; the available equipment; the capacity of the available equipment; and the advisability of using the equipment over-time or purchasing additional equipment to suit. A card should be kept for each machine, showing the size and location of the machine and having space for listing all work assigned to the machine and the estimated time required for each operation. While an elaborate card may be out of place, at least a plain 3- by 5-inch card should be used. If the manufacture of one general product only, is being planned, a cumulative total of the time the machine will be in use, can be carried, either per operation, as shown in Fig. 3, or, if a definite schedule is decided on, for the total average daily production. If a varied class of products is made, the problem will be complicated by the fact that the schedule on one or all of the products may be changed independently of others. If there are not too many products, a solution may be found by using a larger card such as illustrated in Fig. 5, carrying a separate column for each product and adding the time per unit of each product separately. Pencil figures may be used for a compilation of the total machine load according to the individual schedules in force. In this manner, any overload on a given piece of equipment will be quickly revealed. In such cases the machine tool engineer should consult with the chief tool engineer to find out whether the overload can be avoided. If not, steps can be immediately taken to run the equipment over-time, purchase new equipment, or have some of the work done at an outside plant.

W & S NO. 2		EQUIPPED WITH 9" CUSHMAN 2 JAW CHUCK, 6" UNION 3 JAW CHUCK				INV. NO. 212	
MOTOR	MIN.	MODEL A	MIN.	MODEL B	MIN.	MODEL C	MIN.
1025-25	5	1383-20	7	1384-20	7	1385-20	7
1026-15	3	1393-15	5	1394-15	5	1395-15	5
1105-5	10	1397-35	10				
1108-10	6						
TOTAL MIN. PER UNIT	24		22		12		12
NO. OF UNITS	15		5		7		3
TOTAL MIN.	360		110		84		36

Fig. 5. Method of recording Work assigned to a Machine when a Variety of Products is manufactured

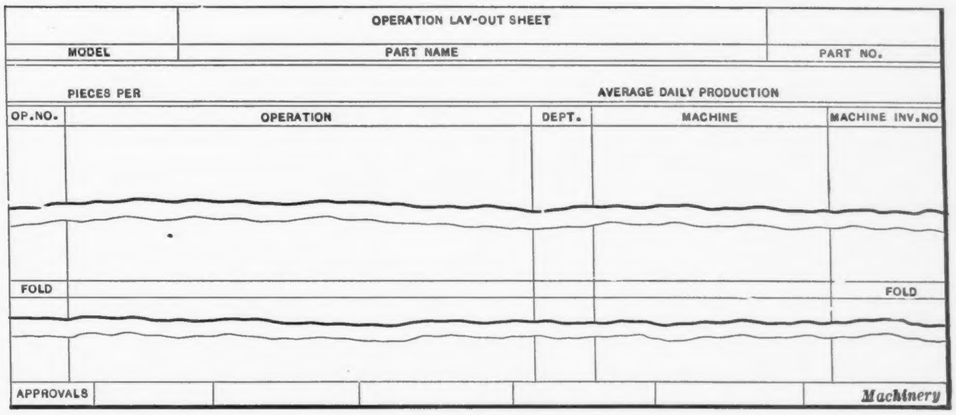

OPERATION LAY-OUT SHEET
MODEL | PART NAME | PART NO.
PIECES PER | AVERAGE DAILY PRODUCTION
OP. NO. | OPERATION | DEPT. | MACHINE | MACHINE INV. NO.
FOLD | FOLD
APPROVALS
Machinery

Fig. 6. Sheet showing the Complete Sequence of Operations on a Part

This feature of protecting the manufacturing schedule from unintentional overloading of the equipment will often pay many times over for the work spent on compilation. Cases have been known where a delivery promised in two months could not have been completed in a year with standing equipment; the management of any concern will naturally appreciate prompt information about such conditions while there is a chance to remedy them and make the promised delivery. In planning the duties of the machine tool engineer, the production planning department should be consulted. It may be found that the latter requires and keeps records which will fulfill the needs of the tool designing section either without change or with slight amplification. If such is the case, arrangements can be made for the co-operation of the tool engineers and the planning department, and this function of the machine tool engineer can be eliminated.

Special Tool Engineer—The function of the special tool engineer is to work out the details of each machining operation. He receives from the drafting-room dispatcher the operation sheet shown in Fig. 6, on which is given the operation lay-out already decided upon by the chief tool engineer. From this sheet and the part drawing, the special tool engineer decides what machine will be best suited to each operation and what sort of jigs and fixtures will give the most economical results. When commercial tools can be used he should specify them. He should make rough sketches of the fixtures desired, and when the lay-out is clearly in mind, he should consult with the foremen of all the departments concerned and get their viewpoints, which should be valuable.

The man in the shop responsible for actual results should always have a chance to express himself before the means by which he is to get the results, are decided upon. To shut oneself up in an office and design something for shop use, whether a tool, a machine or just a form, and then thrust it on the shop without introduction, is the best way to make shop men suspicious of office conceptions and eager to condemn them. Once a tool lay-out is settled upon, detail operation sheets of the sort illustrated in Fig. 7, are made out and orders issued for each tool required. It will happen occasionally, of course, that the tool designers will find modifications necessary, and so final distribution of operation sheets should be withheld until all designs are approved.

Gage Engineer—The gage engineer has the same function on inspection operations as the special tool engineer on machining operations. His method of procedure is therefore very similar, except that he consults with the inspection department instead of with the manufacturing foremen.

Commercial Tool Engineer—The function of the commercial tool engineer is to issue all orders for small commercial tools required. The detail operation sheet in Fig. 7 provides the basis for these orders. Occasionally substitutions will have to be made on account of deliveries or stock-room standards, and for this reason the commercial tool engineer should be familiar with the general run of tools used. In this connection, it is well to arrange for chucks to be assigned to certain machines and considered as part of those machines, rather than to consider them as commercial tools listed on operation sheets. The writer has still a vivid recollection of helping to straighten out a badly tangled situation caused by considering chucks as commercial tools and not paying any further attention to the subject on the operation sheets. The result was that when the commercial tool engineer began to order chucks, there were duplications on some machines and shortages on others. The loss in time of men working to clear the situation amounted alone to several hundred dollars, not to mention delayed production. By arranging for equipping certain machines with chucks, listing these, and assigning parts requiring chucks to the proper machines, not only will confusion be avoided, but also the investment in tools will be reduced to the minimum.

Change Engineer—Changes in tools may be required because their design has been found faulty or requires modification, or because the part may be changed, so that the tools need to be adapted. Where the design is faulty, the trouble should be brought to the attention of the change engineer by the production foreman. These men should go over the matter carefully and decide on remedial measures to be taken. The change engineer should then issue an order to the chief draftsman, stating in some detail just what changes are to be made. In the majority of cases, the order can be so issued that the draftsman can make the changes on the drawing without necessitating a trip into the shop. On the other hand, if a vague order is issued, the draftsman usually goes over all the ground again, wasting his own time and that of the men in the shop who resent having to explain things over again.

When a part is to be changed, if the engineering department is functioning properly, the change engineer receives a notice of the change, which also states whether the part as redesigned can be used to replace any old parts that may be out

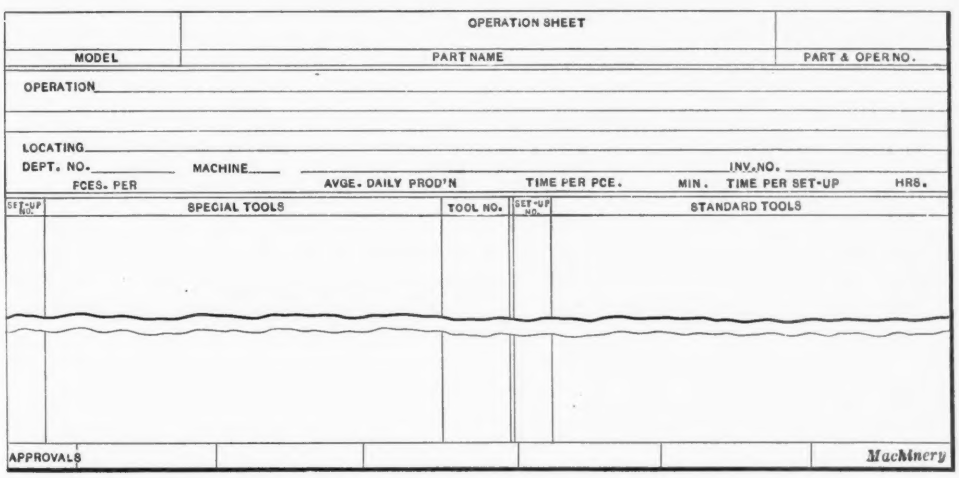

OPERATION SHEET
MODEL | PART NAME | PART & OPER. NO.
OPERATION
LOCATING
DEPT. NO. | MACHINE | INV. NO.
PCES. PER | AVGE. DAILY PROD'N | TIME PER PCE. MIN. | TIME PER SET-UP HRS.
SET-UP NO. | SPECIAL TOOLS | TOOL NO. | SET-UP NO. | STANDARD TOOLS
APPROVALS
Machinery

Fig. 7. Detail Operation Sheet filled out in the Engineering Section of the Tool Division

in service. If so, the tool may be changed without any complications ensuing; the engineer can get out the new blueprint of the part and issue any necessary order for changing the tool. If, however, old parts are out in service and the new part cannot be used for replacements, care must be taken to change the tool in such a way that replacement parts can still be manufactured, and if that is impossible, a new tool must be made.

Operation Sheet Checker—The usual procedure of making out operation sheets is to first develop a rough lay-out of operations; from this the special tool engineer makes rough copies of the detail operation sheets on which he bases his special tool orders and from which the commercial tool engineer issues orders for small tools. Changes will frequently be made on these sheets as the work progresses, and this fact makes it desirable that the entire batch of sheets on each part be checked as soon as all orders are issued. Carbon paper backing should be used in typing the operation lay-out and detail operation sheets so that good blueprints can be made from the originals. The checker should then take the complete set of sheets on the part and check (1) the technical correctness of operation sequence, that is, see that the part can be made as planned; (2) the provision of all necessary tools and operation sheets; and (3) order files to see that all orders have actually been issued. When the sheets have been found correct, necessary blueprints can be made and distributed to those requiring them.

PART NO.	TOOL DESIGN RECORD	DATE OF T.O.	TOOL NO.
TOOL NAME		PART NAME	
TO CHIEF DRAFTSMAN	DATE	TO DETAIL FOREMAN	
		TO CHIEF CHECKER	
DES.APPR.BY		COMPLETED	

Fig. 8. Card used in the Designing Section to record Draftsmen working on Each Job

General Notes on Tool Engineering Section

The fewer men that can be used to cover the activities of the tool engineering section, the better will be the results, as references to other men will be less needed. In a small organization one good man should be able to attend to all tool orders—special, commercial, gages and changes. Distribution of other activities will depend upon the qualification of the men available. Only in large organizations should there be more than one man on each sub-activity shown on the chart in Fig. 1.

Duties of Men in the Tool Designing Section

Chief Draftsman—Under the plan of organization here mapped out, the chief draftsman has little to do with the details of designing; the main outline of a tool required is decided by the special tool engineer and the shop foreman who is to use it, and the details are worked out by the designer with the advice of the design foreman. The function of the chief draftsman is mainly a disciplinary one; certain rules of conduct must be enforced, and established standards of office practice maintained. For the chief draftsman to develop both efficiency and harmony in a large office will entail his possessing considerable tact, firmness, and ability to judge the competency of his men and guide and direct them. Needless to say he should have practical experience and be a good tool draftsman himself so that he will be able to judge both the quality and quantity of work turned out by the individual men.

The chief draftsman may either have the drafting-room dispatcher distribute work to the foremen or have the dispatcher mark the tool orders with priority numbers and distribute them himself according to priority. Where a great many designs are being worked on at a time it is necessary to keep a check on the whereabouts of each one. The card shown in Fig. 8 can be used for this purpose, the name of the man working on the drawing being entered each time the drawing is given out, and the cards filed numerically. In order that the chief draftsman may know what each man accomplishes, he may either make the rounds every day to each board, having the foremen accompany him, or he may have the completed drawings passed over his desk. In either case it is highly desirable that some method be developed to rate the value of each man. While this presents considerable difficulties, it can be done provided common sense is applied in the use of the ratings. The features to be considered are correctness, legibility, and improvements suggested; amount of work produced; habits and character; and general value to the company through knowledge of the business and possibility of developing to hold a responsible position.

Records could be kept separately of each item, and with a proportion of relative values of each, a composite figure built up which would give a fair rating for each man. However, the general experience in efficiency work is that if a quantity measurement of work performed is made and quality inspection rigidly enforced, the quantity measurement alone will suffice; this is because the quality defects produced on unchecked work are usually due to lack of attention, and as soon as an incentive to concentration is offered, quality improves as well as quantity. Owing to the unstandardizable nature of drafting work, accurate estimates are impossible, and it would therefore be incorrect to use these ratings as bases for any of the bonus methods used on regular production. On the other hand, if cumulative totals are kept of actual time worked and total estimated time plus allowances for improvements and changes accepted, these figures over a certain period of time should serve as an excellent guide in making wage rate adjustments. However, no allowances should be made for time consumed in correcting errors of the draftsmen. Unless the company has a special department of standards, the chief draftsman should make up standard practice instructions for designers and checkers and keep these up to date. He should also see that all machine data are accessible.

PART NO.	TOOL DRAWING RECORD	DATE DWGS.COMP	TOOL NO.
TOOL NAME			
PART NAME			
PATTERN NO.			
SHEETS IN SET	D		
	C		
	B		
	A	AA	*Machinery*

Fig. 9. Form on which a Record is kept of Tool Drawings sent to the Blueprint Room

Time Clerk—If a record is required of the cost of each tool, it will be necessary for the men to turn in tickets showing the time they worked on each tool. In this case a time clerk should be provided to check up the time tickets. It should be remembered, however, that the tool cost is influenced by so many casual factors that any attempt at extreme accuracy of cost finding is out of place; time to the nearest half-hour should be close enough for work of this kind. The men should be instructed accordingly so that they do not spend too much time in making

out the tickets. Anyone using the cost records should understand that only approximate tool costs are given. The time clerk should keep on file a card for each man on the department payroll, record of the working time of the man being kept on the card. The time clerk will probably have ample time to prepare reports required by the chief clerk and fill out drawing records for the chief draftsman.

Designers, Detailers, and Checkers, and their Foremen—While there is no question but that the checkers should be separate from the draftsmen and under the supervision of a checker foreman, there are cases where it is advisable to have the detailers under the same direct supervision as the designers. However, if the force is a relatively large one, it will be preferable to have a separate detail foreman in charge of the men doing detail work. This will enable the flow of the work to be more evenly distributed. The detail foreman should be chosen for his ability to instruct and develop men rather than for having wide experience, while the design foremen should be widely experienced men with the ability to foresee difficulties and give designers good technical assistance.

Drafting-room Supply Clerk—The function of the drafting-room supply clerk is to provide draftsmen with all materials, drawings, blueprints, and auxiliary data, and keep records of those to whom such things are given. After long experience in attempting to keep up a large number of standard books, the writer has come to the conclusion that the best way to handle standard sheets is to keep several copies of each sheet, preferably mounted on pasteboard or at least printed on linen, in the supply room in a special file. The index to this file should be posted in an accessible place. Then any man requiring a data sheet can look up the number, draw it out against a receipt, and when through with it, return it to the file. A selection of sheets commonly required may be made and firmly bound together (not in a loose-leaf binder), and every man supplied and charged with a numbered copy. Unless every man is given a copy, it will be difficult to hold anyone responsible for one lost.

Blueprinters and Drawing File Clerk—Orders for the making of blueprints can be made on simple requisition blanks put up in pads. As each drawing is checked, the chief checker should fill out one of these requisitions as authority to print the necessary amount of blueprints, and no tool prints should be made without this authority. Any other blueprints required should be authorized by the chief draftsman; this will serve as a check on indiscriminate printing. As each set of drawings comes to the blueprint room a card, such as shown in Fig. 9, should be made out by the drawing file clerk and filed. This card should be generally accessible; it will prove a time-saver to have the assembly sheet number marked on the card. Standard filing cabinets should be installed to fit the drawing sizes used, and each sheet filed in a drawer of its own size. Drawing sizes and filing methods were discussed in an article entitled "Standard Blanks for Tool Drawings," which appeared on page 786 in April, 1921, MACHINERY.

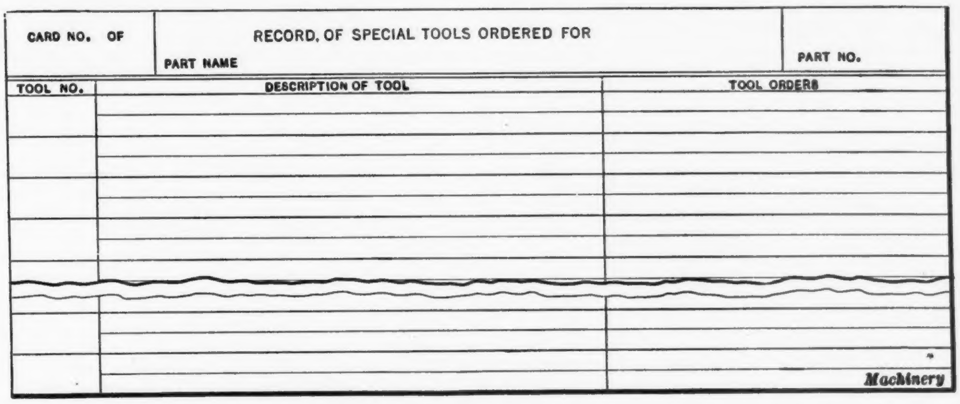


Fig. 10. Record of Special Tools ordered to facilitate the machining of a Part

Work of the Chief Clerk and Tool Work Dispatcher

Chief Clerk—The function of the chief clerk is to see that all clerical work is done promptly and correctly, that record files are properly maintained, and that necessary reports are brought to the attention of the tool superintendent. Copies of all orders issued should be on file and separate sections maintained for incomplete design orders, complete design orders, incomplete shop orders, and complete shop orders. This file is the control point for issuing shop orders, and any special handling desired for the orders can be attended to by placing "ticklers" in this file. It is also necessary to provide a record of all tool orders issued on each part. The card shown in Fig. 10 was designed for this purpose. It will be noticed that provision is made for a full description of the tool, and under "Tool Orders" the symbol and number of tools ordered are to be recorded. The symbol is the designation added to the tool number for indicating what kind of order was issued. Thus on tool No. 582-J-2, if a second repeat order was issued, making the third request for this tool, the order number would read 582-J-2-3.

Regular correspondence files should be kept, and if letters are handed out to men in the drafting-room, receipts should be exacted for them, and these placed in the regular folders until the letters are returned. It is desirable that progress reports be rendered to the tool superintendent by the chief clerk, covering the conditions of the drafting-room and tool-room and the progress of the whole job. The report should show the estimated amount of work in hours and number of designs immediately ahead of the designers, detailers, and checkers, the number of men engaged on each of these activities, the number of men on staff activities, that is, tool engineers, and the number of absentees. The report should also show the total number of tools being manufactured by the tool-room and outside tool concerns, the number of men in the tool-room and the estimated hours of work ahead of them. Since it is assumed that a schedule has been made, it is important to follow up closely the total progress, and it is equally important to check up the accuracy of the estimates. Hence, the chief clerk should furnish a daily report of tools made and corrections of estimates.

Tool Work Dispatcher—The function of the tool work dispatcher is to distribute the orders for tools, after the design is completed, in such a manner as to permit the desired deliveries with the utmost possible economy. Since it is usually the duty of this man to approve bills and pass on estimates, it is evident that the main qualifications for the position are an intimate acquaintance with toolmaking practices, a knowledge of reasonable time charges, and reliability. Since the tool work dispatcher must keep posted on what work the different shops can do, he should have a file showing the equipment of each shop; this will assist him to distribute work economically.

The follow-up file of the tool work dispatcher may consist of cards similar to the one shown in Fig. 4. These will enable him to keep track of the location of all tools on each part and the progress made on each tool. The first vertical line may indicate that castings or forgings are finished, the second, that all parts are finished, and the third, that the tool is completed and has been checked. If the company's tool-room has sufficient capacity to make all, or nearly all the required tools, the duties of the tool work dispatcher should be delegated to the tool-room foreman, who can have a production clerk attend to the follow-up of tools and see that orders are given preference according to the priority numbers marked by the drafting-room dispatcher.

Hand- and Machine-Lapped Surfaces as Seen Through a Microscope

THE manufacture of precision gages, such as gage-blocks and plug gages, requires, first, some method of producing gaging surfaces that are true enough to meet practical requirements, and second, some precise method of checking the gage dimensions. If a gage has a flat surface, the truth of this surface is in proportion to the "effective area" or the amount of "high land" which lies in the same plane. A cylindrical gage is true in proportion to the area coinciding with a true cylindrical surface of given diameter. The term "effective area," therefore, refers to the area of that part of the surface which would make contact with a perfect plane in the case of a flat gage, and with a perfect cylinder when the gage is cylindrical. It is important to note that the finished surface, whether flat or cylindrical, may be highly polished and appear true to the naked eye, when in reality it has a relatively small effective area. Such a surface, if highly magnified, is shown to be a mass of ridges and grooves, which may have considerable polish and yet not form a true surface.

It is evident that a surface having a large percentage of effective area is not only better for precision gaging purposes, but that it also offers much greater resistance to wear, because there is a larger area of contact surface, and for a given amount of metal removed there is less reduction in diameter. In precision gages or the finest grades of work in machine manufacture, the variations between good surfaces and poor ones depend upon differences which are extremely small and yet very important, and in order to carefully study these differences a microscope is employed.

Fig. 1. Exceptionally Good Ground Surface

Fig. 2. Hand-lapped Plug Gage

Fig. 3. Better Example of Hand-lapping

Fig. 4. Machine-lapped Plug Gage

These photomicrographs show examples of ground, hand-lapped, and machine-lapped cylindrical surfaces magnified about 220 times. Each engraving is located with the axis of the cylindrical surface illustrated, in a horizontal position. Figs. 4 and 5 illustrate what has been accomplished in producing exceedingly accurate cylindrical surfaces by a mechanical lapping process which is a modification of that used for flat surfaces.

Fig. 5. Exceptionally Fine Machine-lapping

Several interesting examples of photomicrographs made by the Pratt & Whitney Co., Hartford, Conn., in connection with a study of the characteristics of different surfaces, as obtained by various methods, are shown by the accompanying illustrations. Each of these photomicrographs represents a small part of a cylindrical surface, and the different views are so arranged on the page that the imaginary axis of the cylinder is in a horizontal position in each instance. The original views were magnified 280 times, but these halftone reproductions have been reduced so that they show a magnification of about 220. All these views are to the same scale and they have been supplemented by cross-sectional diagrams, Fig. 6, which illustrate the relative depths and numbers of the grooves. These diagrams are conventional representations of an average count of scratches over considerable area of the various blocks. In all photomicrographs of lapped surfaces, the preliminary grinding marks have been removed by lapping. The scratches are due entirely to the lapping abrasive.

Results Obtained by Hand-lapping

Fig. 1 shows the surface of a commercial plug gage which has been ground but not lapped. This is an example of an exceptionally good ground surface. Fig. 2 shows the surface of a hand-lapped commercial plug gage, but this does not represent good lapping practice. Another example of hand-lapping is shown in Fig. 3. This is a Pratt & Whitney master plug gage. A comparison of this hand-lapped surface with the one illustrated in Fig. 2 shows that the former is

much more uniform, and has a much larger effective or highland area.

Results Obtained by Machine-lapping

Figs. 4 and 5 illustrate what can be accomplished by machine-lapping, assuming that it is done in the right way. A first-class finish for a precision plug gage is represented by Fig. 4. While its surface has been machine-lapped, no attempt has been made to give it the extreme degree of finish or polish represented by Fig. 5. Both of these surfaces, however, are practically the same, so far as wearing qualities and usefulness are concerned, but to produce a finish like that shown in Fig. 5 requires probably eight times as long as to secure the surface shown in Fig. 4. For this reason, one is regarded as a commercial finish for precision gage work, whereas the other is more in the nature of a "stunt." It should be remembered that the commercial finish represented by Fig. 4 is a very fine and highly polished surface, and that it is only by extreme magnification that the minute scratches on the surface are revealed.

It will be noted that the scratches seen in Figs. 4 and 5 are short, and either parallel with the axis of the plug or slightly inclined. On the contrary, scratches on the hand-lapped gages extend diagonally around the work, due to the use of a ring lap which is given a traversing movement. The finer surfaces on the machine-lapped plugs are obtained by performing a lapping operation between two flat cast-iron plates having very true surfaces and operating in such a way that the plugs receive a combination of rolling and sliding action. These lapping machines are similar in principle to the ones used for lapping the flat surfaces of precision gage-blocks, which were described in April, 1920, MACHINERY, beginning on page 702 of the article entitled "How Precision Gage-blocks are Made." However, the lapping of true cylinders between flat plates requires an interesting modification of the process utilized for flat surfaces. The "Trilock" reversible plug gages made by the Pratt & Whitney Co., are finished by this modified process, which has also been applied to other commercial products, such, for example, as automobile piston wrist-pins.

In developing this process, the original aim was to produce a cheaper quality of working plug gage by eliminating the expensive hand-lapping operation. It was soon found possible to produce much more accurate results than by hand-lapping and at a fraction of the cost, assuming that the machine-lapped process is applied to the production of duplicate pieces on a quantity basis. This mechanically derived lapping action is not merely one of polishing, but as the photomicrographs indicate, it generates a surface that is practically perfect. A number of these cylindrical gages or other parts are lapped simultaneously, and by systematically and repeatedly transposing them and averaging the errors, the entire lot is finished to a true cylindrical form to within, say, 0.00001 inch or less. Some essential features of this process are covered by patent applications now pending, so that this ingenious method of machine-lapping cylindrical parts cannot be fully described at the present time.

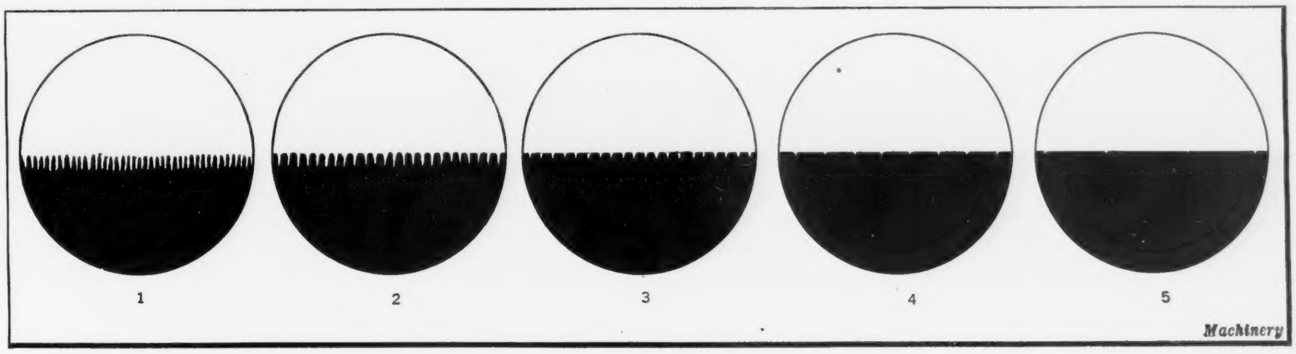


Fig. 6. Conventional Representations of Scratches on Lapped Surfaces. The Diagram Numbers are the Same as Figure Numbers of Corresponding Photomicrographs

RELATION BETWEEN OUTPUT AND COSTS

By JOHN D. RIGGS

At this time when everybody is making an effort to reduce manufacturing costs it is important to understand fully the relation between rate of production and final cost. When the rate of production on a certain article is increased, it is frequently assumed that there has been a corresponding decrease in the cost. A careful analysis of the elements of cost would often show, however, that there are large factors that are independent of the time consumed; for example, the material used is sometimes a large factor in the cost.

Not all innovations are improvements in regard to cost reduction. As an example, imagine the results if the machines in a mill for making wire nails were run at double the ordinary speed without making any other changes in these machines. Production might be doubled forthwith, but the number of machines which an operator could handle would be cut in half. Furthermore, the maintenance cost would probably be quadrupled, and the useful life of the machines might be reduced to about one-fourth. As a result, the cost of nails per keg would certainly not be materially reduced.

Another example is the case of a plow works which, after having grown from a small beginning to a plant employing over 3000 men, decided to rearrange its share department. The making of a plowshare involves about seven operations, apart from the final polishing and painting. These operations were all performed at a satisfactory rate, except the fifth one. A diagonal and beveled end had been trimmed on a grinder after several attempts at shearing it had failed. The superintendent finally ordered a machine for trimming these ends, and in due time a shearing machine, arranged with an automatic hold-down and adjustable stops, so as to accommodate about twenty-five of the thirty-seven varieties was produced and installed. This shear did in about two seconds what had taken one minute on the grinding machine; it was also a cheaper machine. The superintendent was delighted, but the owner and manager did not enthuse. To him a reduction of one cent in the cost of a plowshare which sells at retail for about $4, was not of the greatest importance.

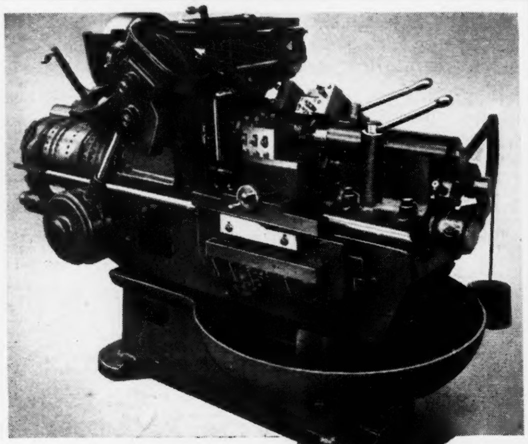
Of the two men looking at the same device one saw an increase in production of from twenty to thirty times the past records, while the other saw a reduction of about ½ of 1 per cent in the production cost of the article, or ¼ of 1 per cent of its retail selling price, coupled with the cost of a new machine.

* * *

The Patent Office relief bill, which has been before Congress almost continuously for the last three years, has been passed by both the House and the Senate. The bill provides for increasing the salaries of the principal examiners from $2700 to $3900 a year, and the pay of the assistant examiners has been raised by $150 to $900 a year. The Commissioner's salary has been increased from $5000 to $6000 a year.

Tooling Equipment for Automobile Hubs and Pistons

By RALPH E. FLANDERS,
Manager, Jones & Lamson Machine Co., Springfield, Vt.



THE front wheel hubs of automobiles are usually malleable castings and can be machined rapidly and accurately without severe cutting strains resulting, if they are properly annealed. The set-up of a double-spindle production lathe for machining the ball-race seats of front hubs is illustrated in Fig. 1. The work is first held in an air-operated chuck in the rear spindle and the inside of the large end is bored, the outside rough-turned, and the end faced and chamfered. The cross-slide is then shifted to bring the sizing reamer and finish-turning tool into position.

After the part is machined by these tools, it is changed to the front spindle and the end just finished is drawn against a hardened adapter by means of an air-operated draw-bar having a T-head that engages ribs cast in the interior of the hub for this purpose. This example illustrates the service that the designer of parts to be machined can render the tool designer if they keep in touch with each other. Without these ribs the part would be difficult to hold. The operation on the small end of the hub is similar to that on the large end.

The usual procedure is to have the bolt holes in the flange drilled or punched next, and then to have the outer bearing races pressed into place. After these operations, the hub is sent to a Fay automatic lathe in which it is supported on taper plugs mounted on the main and tail spindles, as shown in Fig. 2. The tail-spindle is mounted on ball bearings and revolves with the work. With the hub thus accurately mounted on its bearing races, true running of the part when it is completed is assured.

To perform the roughing step in the shortest possible time, both the facing and the long turning cuts of this operation are divided between two tools, which are first fed at an angle relative to the work, as shown by the arrows in the illustration, until they have reached the desired depth. The work is driven by a dowel engaging a bolt hole in the flange. The finishing operation, the tooling equipment for which is shown in Fig. 3, is similar to the roughing operation. In this case, however, the cuts are not divided between two tools, and extra tools are provided for rounding corners and for necking. The output of one roughing or finishing machine and one operator is seventy-five hubs per hour, provided the castings are well annealed.

Operations on Rear Hub Forgings

A typical rear hub made from a steel forging is machined in a double-spindle flat turret lathe with the tooling equipment shown in Fig. 4. The tools are all fed end on, and their arrangement is self-explanatory. While this hub is only occasionally made of malleable iron, it should be possible in such cases to machine it on a double-spindle production lathe similar to that used for the front hub, provided the hole is first drilled in a heavy-duty drilling machine. Fig. 5 shows the manner in which the hub is rough-turned and rough-faced in a Fay automatic lathe, the work being mounted on a taper arbor and driven by a dowel engaging one of the bolt holes in the flange which is drilled prior to this operation. The turning and facing cuts are each divided between two tools, as in the case illustrated in Fig. 2. The finishing operation on the part is illustrated in Fig. 6. Tooling equipment for a hub of a similar type is illustrated in Fig. 11.

A stamped hub flange is machined in a Hartness automatic equipped with the tooling shown in Fig. 7. The operation is simple; the upper tool-holder carries a rough-boring tool which operates while the holder is being fed toward the work, and a finish-boring tool which operates while the holder is being withdrawn, both cuts being short. The facing cut is a long one, and is divided between two tools in the lower holder, one facing from the outside toward the center and the other facing from the center to the periphery. It would, of course, be possible to both rough- and finish-face the part in this operation if that should be necessary.

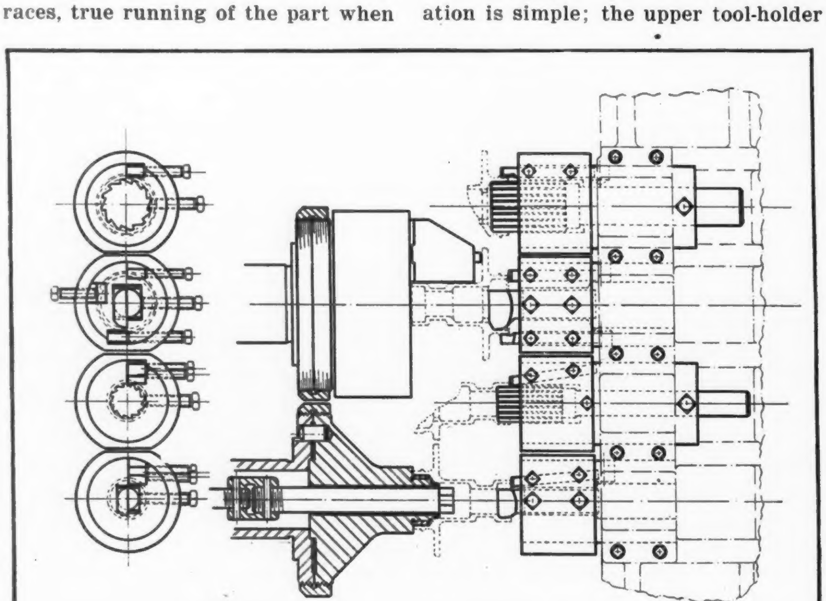


Fig. 1. Set-up of Double-spindle Production Lathe for machining the Ball-race Seats of Automobile Front Hubs

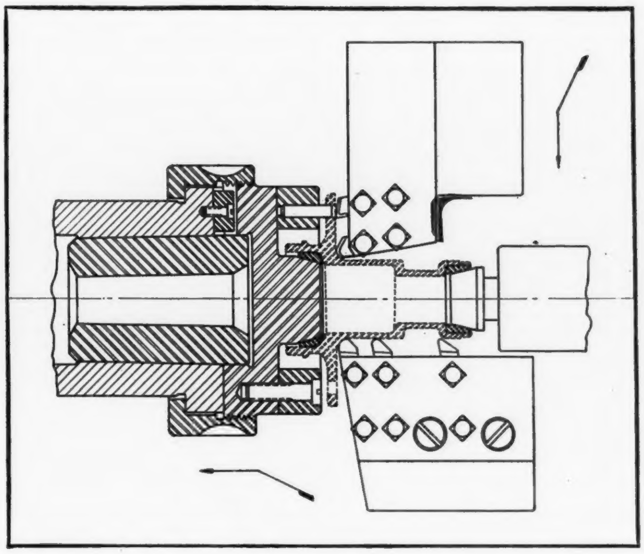


Fig. 2. Hub supported by the Ball Races for the Rough-facing and Rough-turning Steps

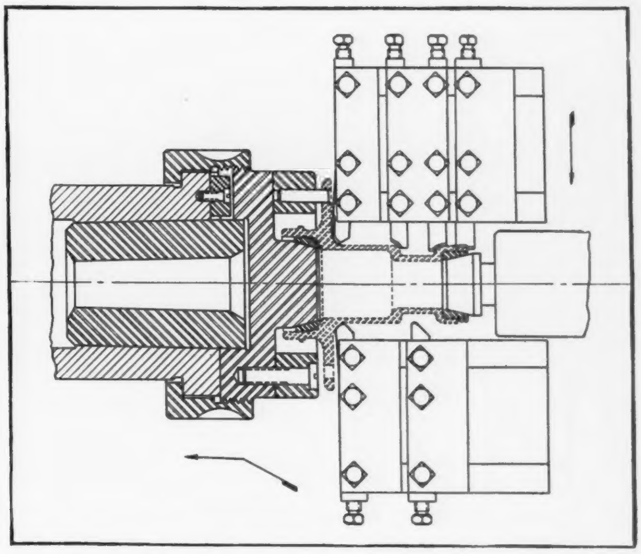


Fig. 3. Finishing Operation in which the Work is supported in the Same Manner as in Fig. 2

Finishing Aluminum Pistons

The machining of aluminum pistons made from die-cast blanks is simple and, owing to the fact that the pistons come from the permanent molds with walls of uniform thickness, no special precautions are required in chucking. In the first operation, which is performed in a Fay automatic lathe, the tool set-up shown in Fig. 8 is employed. The tools in the rear holder rough-bore and rough-face the skirt, while those in the front holder finish-bore, finish-face, and chamfer this end. Meanwhile, a high-speed center-drill driven through the spindle of the machine is advanced to center the boss on the closed end, which is gripped by the chuck jaws. Steps in the jaws locate the piston longitudinally. It should be observed that the skirt is projected far enough beyond the jaws to be free from clamping strain. Only a light pressure of the jaws is required to hold the work in place. This operation is performed so fast that one man can run only one machine, and the output is largely determined by the dexterity of the operator in loading and unloading the work.

The second operation is also performed in a Fay automatic lathe. The piston is held against an

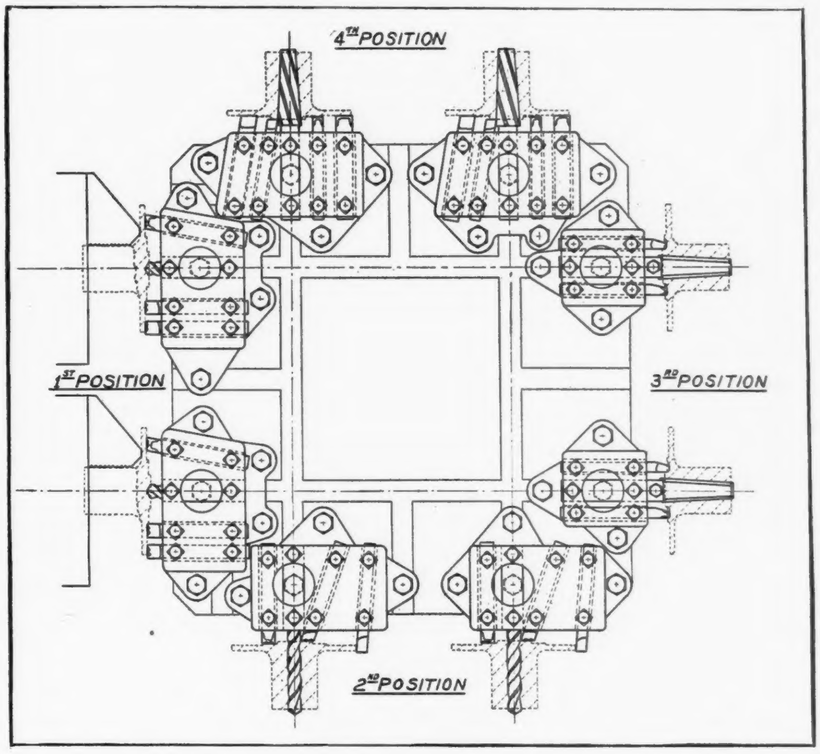


Fig. 4. Tooling Equipment used on a Double-spindle Flat Turret Lathe for machining an Automobile Rear Hub

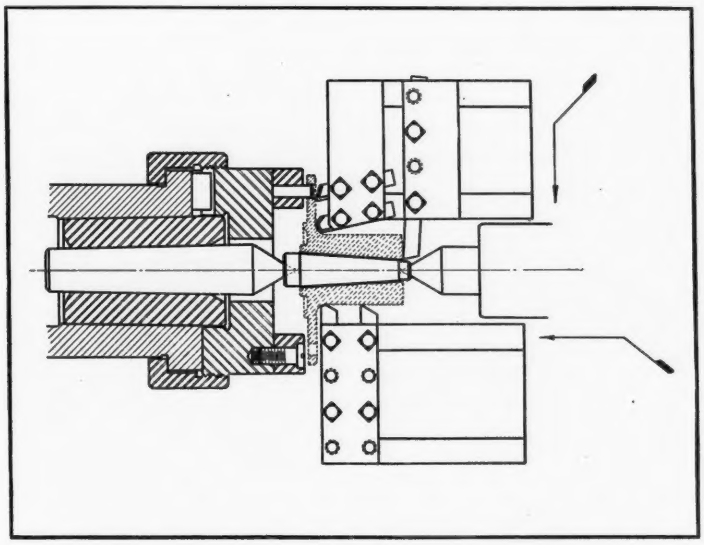


Fig. 5. Rough-turning and rough-facing the Rear Hub in a Fay Automatic Lathe while mounted on a Taper Arbor

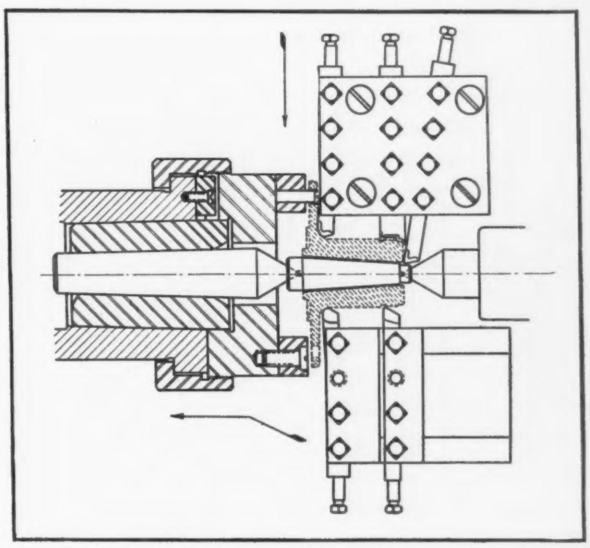


Fig. 6. Finishing Operation on the Rear Hub which is also performed in a Fay Automatic Lathe

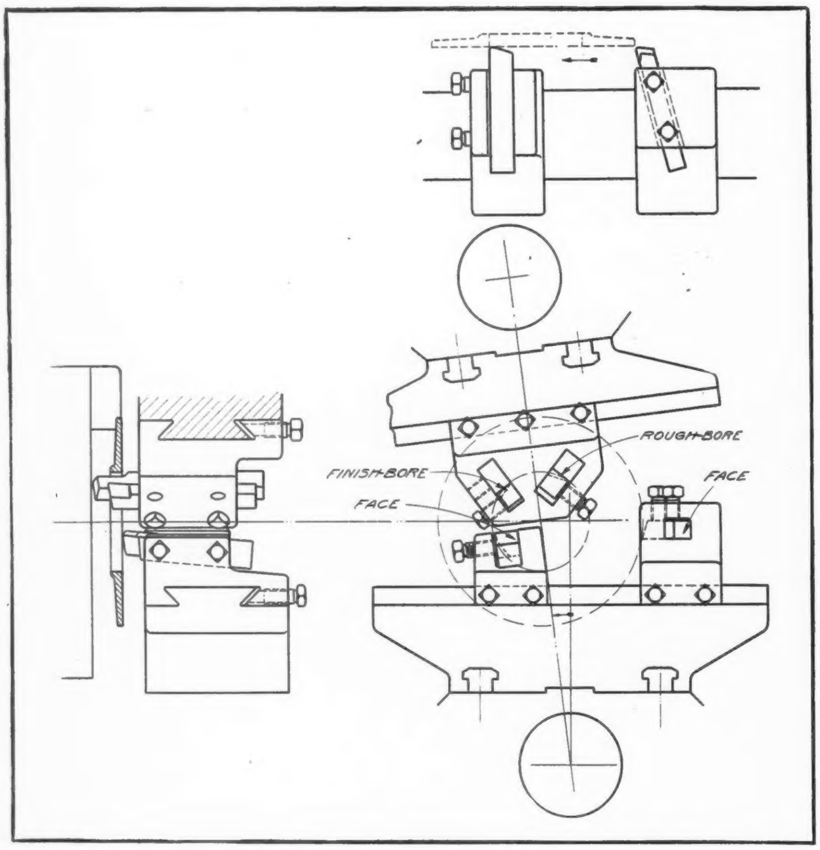


Fig. 7. Tooling Equipment for boring and facing a Stamped Hub Flange in a Hartness Automatic

adapter on the spindle by a ball-bearing tail-center, as shown in Fig. 9, and is driven by a floating fork that engages the wrist-pin bosses. The rear holder is fed radially so that the tools can face the closed end and rough out the grooves. Meanwhile the front holder goes through the somewhat complicated movement shown by the arrow. The turning tool first feeds to depth and then turns the length of the piston, after which the tool-holder feeds in radially once more to bring the tools into position to finish the grooves. The back arm, in the meantime, returns to its original position during which movement the facing tool takes a finishing cut over the closed end.

Only one cut is taken across the outside cylindrical surface, because this surface is ground later. By supporting the work with the tail-center shown, end play of the spindle is taken up and grooves are produced whose side surfaces are planes that match the ground sides of the rings. This obviates a finish-grooving operation in an engine lathe, such as is frequently necessary with first-class work. The machine provided with this tooling is shown in operation in Fig. 10. The operation is extremely rapid, the speed of the work being between 500 and 600 feet per minute, and the production per hour one hundred pistons. One man can run only one machine. The tools can be used several days without requiring resharpening.

Equipment for Machining Cast-iron Pistons

The machining of cast-iron pistons will be described somewhat in detail, as the sequence of operations is the result of a long study and the experience of many makers. This is an excellent example of the interdependence of various operations. The castings are first annealed; this makes them easier to machine, but the primary purpose is to retain the accuracy of the different surfaces after the scale has been removed. Pistons should be made with a good sized boss on the closed end so that a deep center can be provided for supporting the work on the various machines. High production is obtained by taking heavy cuts, and so a small center will not be satisfactory. In the first operation, the piston is placed on a mandrel and centered true with the rough core in an operation on a drilling machine. The inside of the piston head locates on the top of the mandrel, and a stop-collar is used on the machine spindle.

The second operation is performed in a Fay automatic lathe equipped with the tooling shown in Fig. 13. A revolving ball-bearing center holds the head of the piston against an internal mandrel, insuring an even thickness of wall at the head. The plugs of the mandrel are expanded by air pressure and center the piston true with the core at the open end. This arrangement, together with the true center, insures an even wall thickness throughout. A balanced driving member engages the wrist-pin bosses. The tools in the back holder rough-face the open and closed ends and rough-groove the work. Meanwhile the tools carried by the front carriage rough-turn the piston, a sufficient number of tools being provided to turn the entire length of the work in the short time required for facing the closed end. The latter step establishes the cutting time for the whole operation. The production rate of this machine on 3¾-inch diameter pistons is from forty-five to fifty per hour. By having an operator run two machines, from ninety to one hundred pistons can be turned out per hour.

Third and Fourth Operations on the Piston

The wrist-pin holes are rough-drilled in the third operation by using a fixture in which the work is located by the outside cylindrical surface and the finished end, and angularly by means of the internal bosses. This operation completes the removal of scale and the bulk of the material. A little time for seasoning should be allowed at this point.

The fourth operation consists of machining the skirt in another Fay automatic lathe with the tooling shown in Fig. 14. Since the outside cylindrical surface was turned true

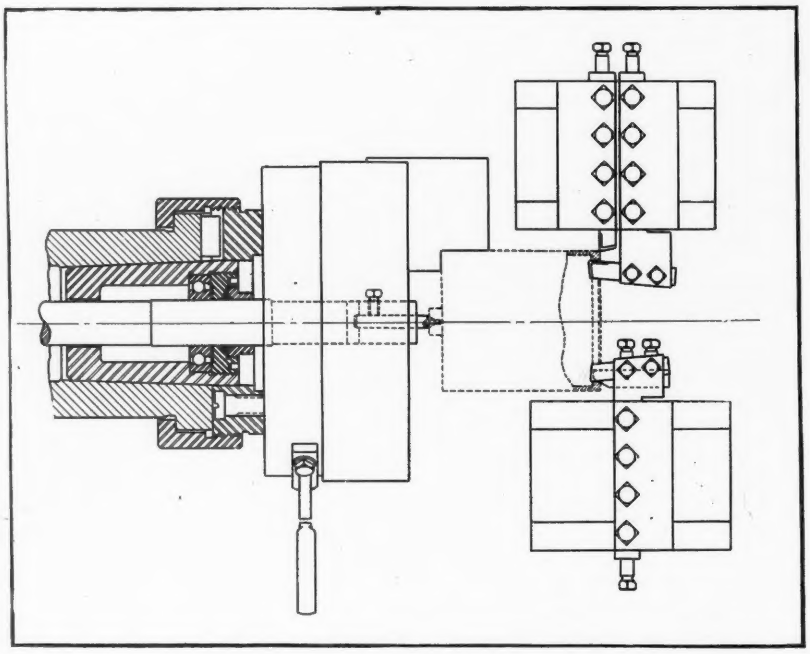


Fig. 8. Roughing and finishing Skirt of Aluminum Piston and centering Closed End

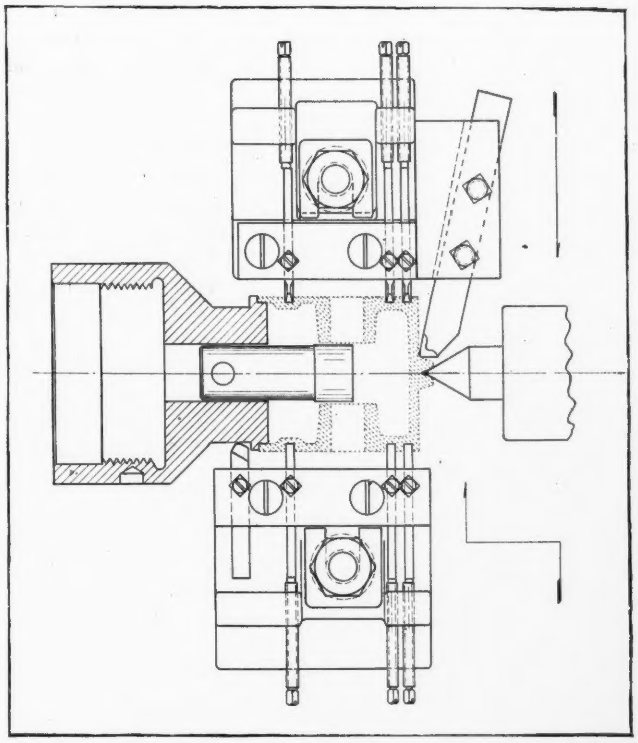


Fig. 9. Turning, facing, and grooving the Aluminum Piston

with the core in the second operation, this surface is utilized in holding the part for finishing the skirt. The piston should project far enough from the jaws to be free from distortion resulting from the gripping of the jaws. The tool in the rear holder rough-bores the work while the front tools finish-bore and chamfer it. The boring is kept within limits of plus or

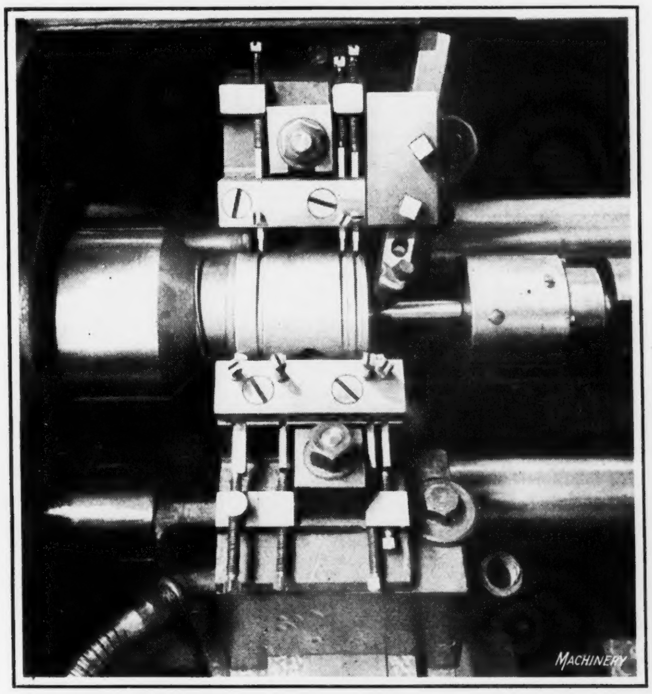


Fig. 10. Machine provided with the Tooling Equipment illustrated in Fig. 9

minus 0.001 inch so that the skirt will be a good fit on the fixtures used later in finish-turning, grinding, and other operations. The possible production in the fourth operation is from 150 to 180 parts per hour, depending upon the rapidity with which the operator can change the work. He can run only one machine at a time in this step.

Finishing Operations—Turning, Grooving, and Facing

In the fifth operation, the piston is finish-turned, finish-grooved, and finish-faced in a Fay automatic lathe provided with the equipment shown in Fig. 16. Here the open end is centered on a hardened seat of the spindle fixture, while the closed end is supported on a ball bearing center, the same as in the case illustrated in Fig. 13, and a balanced drive is used on the wrist-pin bosses. The construction of the center is shown in Fig. 16. A central air-operated plunger strips the work from the fixture when it fits too tightly, and a lever type of tailstock is used for pressing the work on the fixture. The tooling arrangement is nearly identical with that used in the second operation. The outside cylindrical

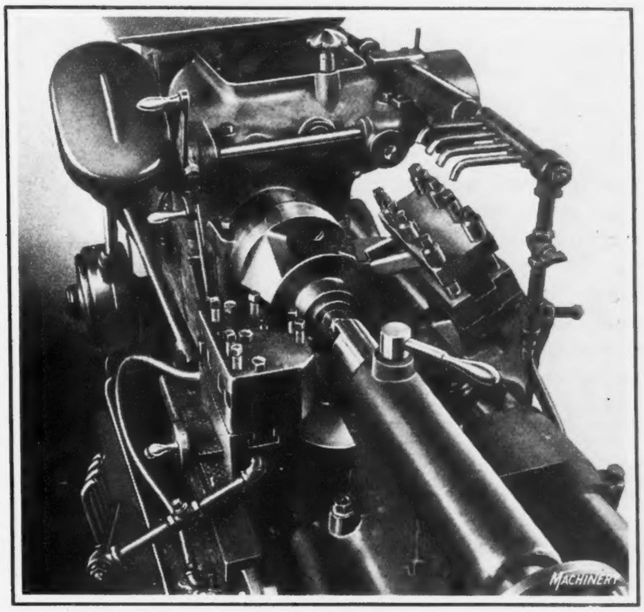


Fig. 11. Another Tooling Equipment for machining a Rear Hub in a Fay Automatic Lathe

surface of the piston is finish-turned for grinding, while the open and closed ends are finish-faced and the grooves finish-turned to the final dimensions.

An intermediate cut is taken on the grooves by tools in a supplementary holder provided beneath the work, as shown in Fig. 15. Thus, the finishing tools of the grooves have little to do and retain their size for a long time. This removes one of the chief annoyances of piston manufacture, which is the holding of the ring grooves to the small tolerance demanded. Advantage is also taken of the pressure of

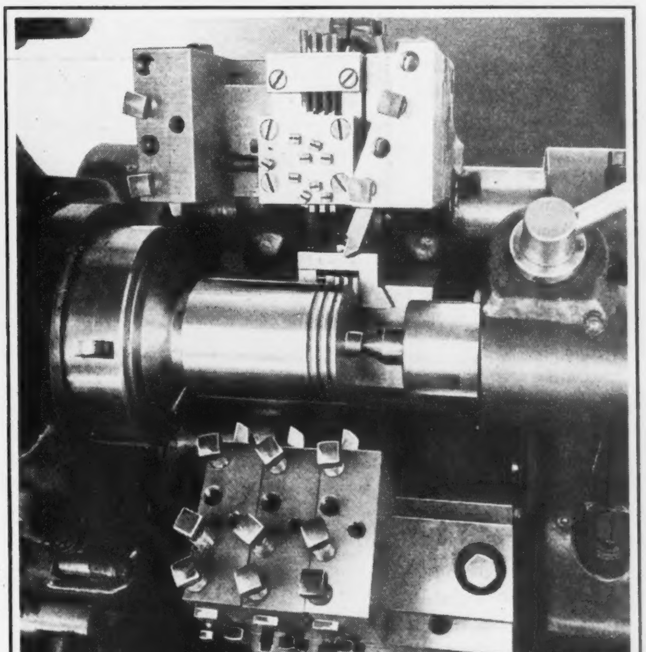


Fig. 12. Close-up View of a Machine engaged in finishing a Cast-iron Piston

the tail-center to eliminate end play of the spindle, and so the grooves in the piston are machined with true faces.

The machine used for this operation is shown in the heading illustration, and a close-up view of the tooling is shown in Fig. 12. The turning tools are automatically relieved on the return movement to prevent scoring the work. The production in roughing and finishing the piston is about the same—from forty-five to fifty pieces per hour, per machine, for a 3¾-inch diameter piston, or ninety to one hundred pistons per hour on two machines run by one operator. The speed used in finishing is higher than that used in roughing, but a finer feed is employed.

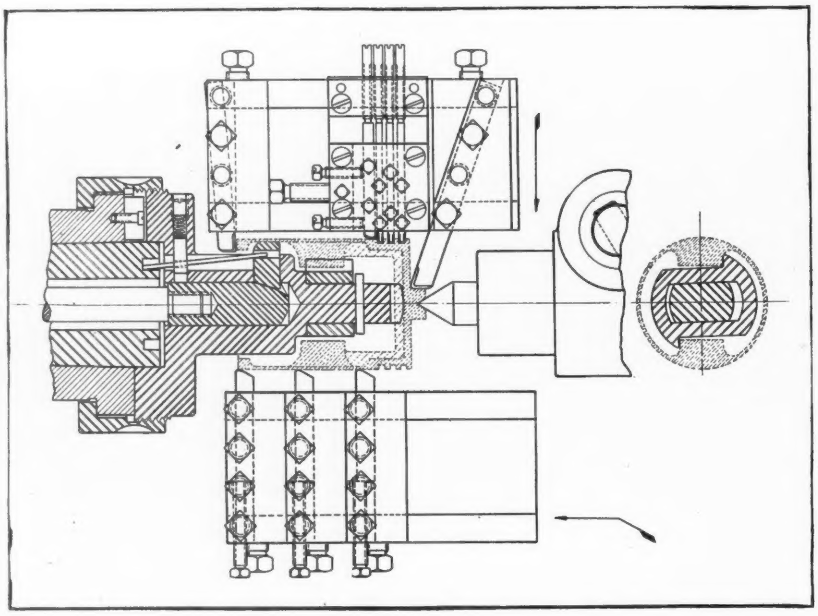


Fig. 13. Tooling used for taking Roughing Cuts on a Cast-iron Piston. Special Attention is called to the Means of supporting the Work

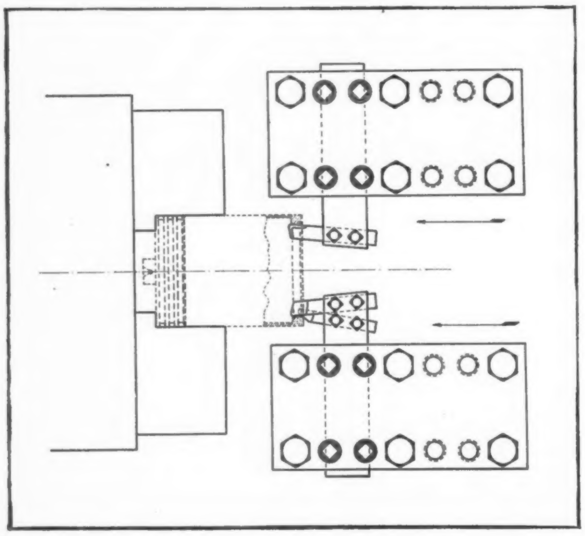


Fig. 14. Rough- and finish-boring and chamfering the Skirt of the Piston

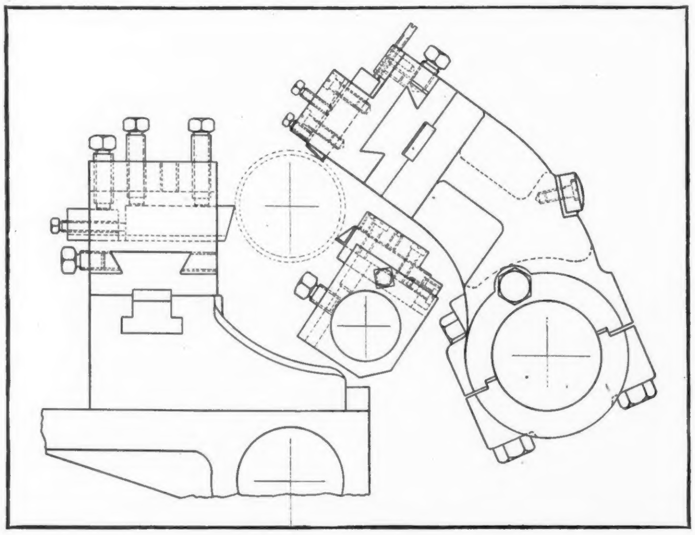


Fig. 15. Illustration showing the Intermediate Holder of the Tooling in Fig. 16

Final Operations on the Piston

The remaining operations on the cast-iron piston are as follows: In the sixth operation, the portions opposite the wrist-pin holes are relieved. In the seventh operation, the wrist-pin holes are finish-bored and reamed. In the eighth operation, the oil-holes, etc., are drilled. In the ninth operation, the chamfer of the skirt is ground to eliminate distortion (this operation is often omitted). In the tenth operation, the outside cylindrical surface of the piston is finish-ground, being located by the chamfer of the skirt, while the closed end is supported by a dead center. In the eleventh operation, the center boss on the closed end is removed on a hand milling machine. In the last operation, the closed end is disk-ground. Further refinements with a somewhat decreased production are required for the very thin-walled cast-iron pistons found in some engines of recent design.

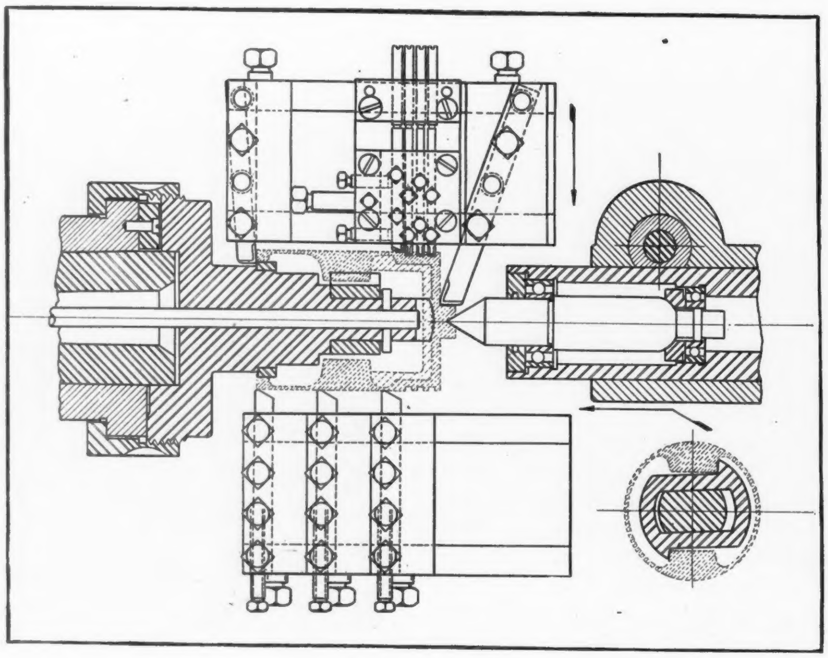


Fig. 16. Finish-turning, grooving and facing the Piston with Tooling Similar to that shown in Fig. 13

* * *

It is estimated, according to a statement that was published in a recent number of *Review of Industry*, that the world's production of iron and steel in 1921 aggregated 64,623,000 gross tons, as compared with 118,093,000 in 1920 and 98,464,000 in 1919.

Cutting Spur Gears on Gear Shapers

Use of Machines Operating with a Planing or Shaping Action and Forming Gear Teeth by Generating and Formed-cutter Processes

Third Article of a Series on the Use of Different Types of Gear-cutting Machines for Cutting Various Classes of Gearing

THE gear-cutting machines referred to in previous articles in this series form spur gear teeth either by using a cutter which reproduces its shape, or by using a cutting tool that is guided by a templet or master former. Tooth curves produced by these two general types of machines are the result of what might be called a copying process. When cutting spur gears by using a generating type of machine, the gear teeth are formed as the result of certain relative motions between gear blank and cutter, instead of simply reproducing the shape of a formed cutter or controlling templet. This particular article is confined to machines which operate with a planing or shaping action, and the first ones dealt with are generating types. A very common type of spur gear generator forms the teeth by milling with a revolving cutter or hob, and the next article of this series will deal with the use of machines of this kind.

Principle of Generating Process of Forming Gear Teeth

When a series of formed cutters is used for cutting spur gears, it is evident that the curvature of any cutter of a set can only be absolutely correct for a given number of teeth. Theoretically, there should be a different cutter for every number of teeth of a given pitch, but in practice this is not necessary. While the error in shape for other tooth numbers within a limited range may be negligible for ordinary requirements, nevertheless it was considered desirable in the development of gear-cutting processes to utilize a method, especially for certain classes of work, that gives the required curvature even though the number of teeth varies. This may be accomplished by a generating method, but the use of a generating type of machine does not always result in greater accuracy than the use of well-made formed cutters, since much depends in either case upon the condition of both machine and cutter and other factors of a mechanical nature. However, a generating process has the inherent advantage of being theoretically correct and of enabling a cutter of a given pitch to cut gears having different numbers of teeth to the correct shape, except for purely mechanical errors such as occur in varying degrees with any method.

In order to illustrate the principle of the generating process of gear-cutting, assume that a finished gear having teeth of correct form is revolved while in contact with a blank, which for purposes of illustration is assumed to be made of some soft, plastic material. The nature of this rolling action would be to generate teeth on the plastic blank. Thus, the teeth on the finished gear, as they roll into contact with the blank, form teeth having the curvature required for meshing properly with the generating teeth. This is a simple illustration of the principle of the generating process. Now, if this tooth forming or generating gear were hardened, and its teeth given suitable clearance, the cutter thus formed could be used to generate teeth in a cast-iron or steel blank, provided the cutter had a reciprocating action parallel to the axis of the blank, while both cutter and blank slowly revolved together, the same as two gears in mesh. This method of using a gear-shaped cutter is employed on a type of machine which will be dealt with later.

Another method of generating gear teeth is to give the gear blank a rolling movement relative to a rack-shaped cutter. It is possible to employ either a gear-shaped or a rack-shaped cutter for the following reason. A rack can be designed, for any system of interchangeable gearing, which will mesh correctly with a range of gear sizes of the same pitch. Moreover, all gears that will mesh properly with the rack will also mesh with one another. Generating processes of

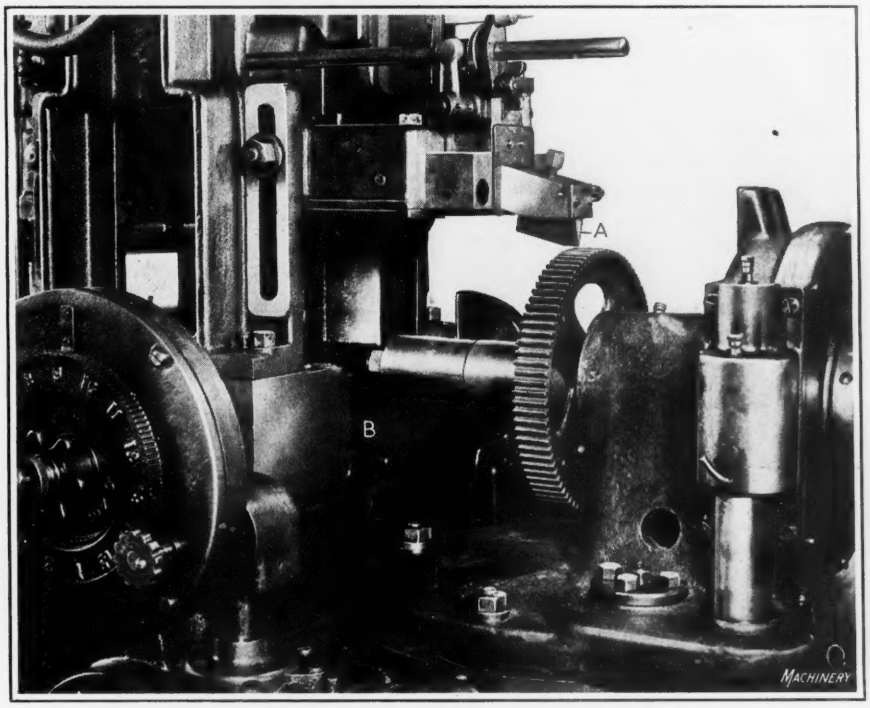


Fig. 1. Gear Planing Machine which generates the Teeth as the Tool, representing a Rack Tooth, feeds laterally

cutting gears are based on this interchangeable feature, which also accounts for the fact that one cutter may be used for cutting various sizes of gears of the same pitch. The cutter represents either a rack or a gear of the interchangeable series, and it cuts or generates teeth as the uncut gear blank and cutter are given movements, relative to each other, similar to a finished gear running in mesh either with a rack or with another gear, depending upon the type of cutter that is used.

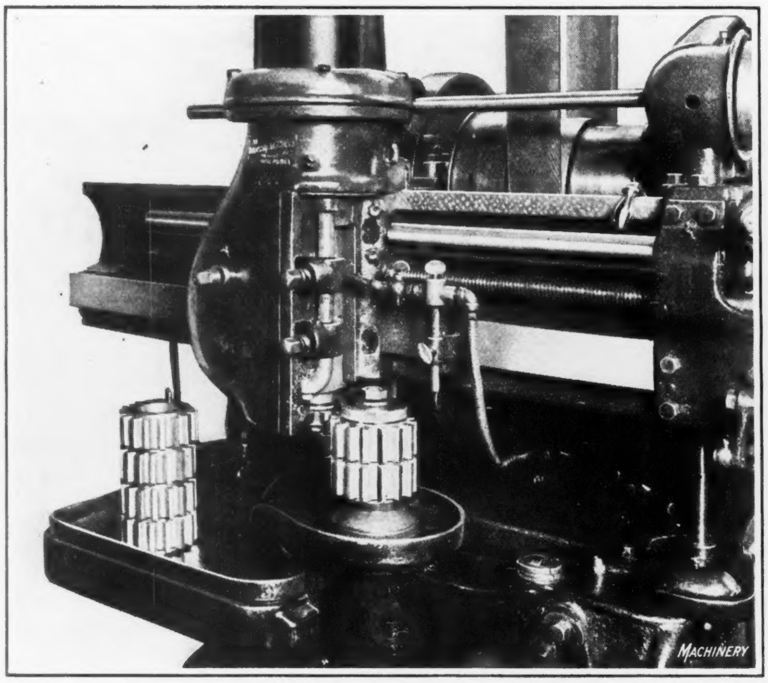


Fig. 2. Gear Shaper which generates the Teeth as the Reciprocating Cutter and Work slowly rotate like Two Gears in Mesh

Relation of the Rack to Gear-cutting Processes

Several types of gear-cutting machines that form gear teeth by generating methods use cutting tools which are shaped like the teeth of a rack, at least so far as the cutting edges are concerned. For instance, one type of spur gear shaper or planer uses a tool that is like a single rack tooth; another type of planer uses a tool having several teeth and resembling a short rack section; then there is the gear-hobbing machine that uses a rotating hob having rack-shaped teeth. The common types of machines for cutting bevel gears by a generating process use tools having cutting edges which represent the sides of crown gear teeth, the relation between a crown gear and a bevel gear being similar to that of a rack and a spur gear.

In order to understand different generating processes and why rack-shaped tools are often used, it is essential to know how the rack tooth form is derived and how it is related to the tooth curves of mating gears. The most important fact about a rack for the involute system of gearing which is now in general use, especially regarding its relation to gear-cutting processes, is that the sides of the teeth are straight. (In actual practice, the perfectly straight tooth form frequently is not used, as, for example, when it is altered somewhat to prevent interference with a pinion or when a rack is milled by using a cutter that is applicable either to racks or spur gears of large radius. This modification of the rack tooth form, however, need not be considered at present, since it pertains more particularly to rack cutting.) Another important fact about a rack tooth is that each side of a given tooth inclines from a plane perpendicular to the pitch line of the rack an amount equal to the pressure angle of the gearing (usually 14½ degrees, but often 20 degrees). Just why the sides of involute rack teeth are straight and why their inclination is the same as the pressure angle will be apparent when the development of tooth curves for involute gearing is understood. By studying the principles underlying these tooth curves, and particularly the relation between a rack and its mating gear, a clearer understanding of the generating processes of gear-cutting will be obtained.

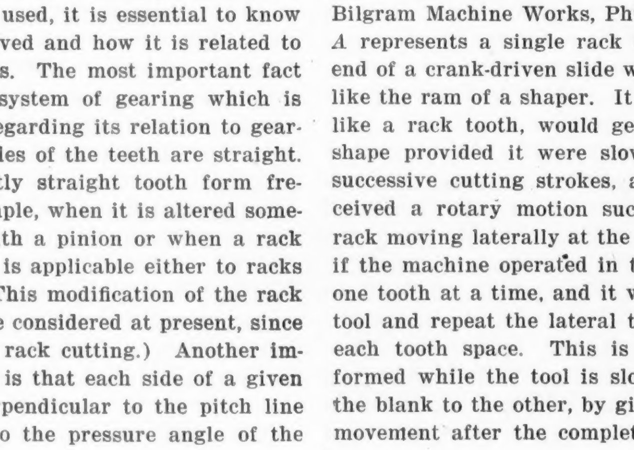


Fig. 3. Diagram illustrating Action of Gear Shaper shown in Fig. 2

The fact that an involute rack tooth is straight-sided is of considerable practical value, as applied to the making of cutters for different types of machines which form gear teeth by a generating method. It is evident that there is a decided advantage in having either a straight-sided tool or a straight side as a basis to work from. For example, if a gear-cutter is in the form either of a single rack tooth or of a short rack section, the work of making an accurate cutter is much simpler than it would be if the cutter teeth had to be given some special curvature. Similarly, if the cutter, instead of representing a rack tooth, is in the form of a gear (like the cutters used on Fellows gear shapers) the practical advantage of the straight-sided rack tooth is obtained, because the teeth of these cutters are ground to correct curvature by rolling the cutter in contact with the straight side of a grinding wheel. The grinding wheel, in this case, represents the rack tooth, and the curvature of the cutter is the result of a generating process.

Cutting Spur Gears on Machine of Generating Planer Type Using Single Rack-tooth Cutter

The first gear-cutting machine of the generating type to be considered is the Bilgram machine, which is shown in Fig. 1 cutting a spur gear. This machine is made by the Bilgram Machine Works, Philadelphia, Pa. The cutting tool *A* represents a single rack tooth, and it is attached to the end of a crank-driven slide which has a reciprocating motion like the ram of a shaper. It is evident that this tool, shaped like a rack tooth, would generate a tooth space of correct shape provided it were slowly traversed laterally between successive cutting strokes, assuming that the gear also received a rotary motion such as would be derived from a rack moving laterally at the same rate as the tool. However, if the machine operated in this manner, it would form only one tooth at a time, and it would be necessary to return the tool and repeat the lateral traversing movement for cutting each tooth space. This is avoided and all the teeth are formed while the tool is slowly traversed from one side of the blank to the other, by giving the gear blank an indexing movement after the completion of each cutting stroke.

Lateral Traversing and Indexing Movements

During each return stroke the tool is lifted automatically to clear the gear, by a suitable mechanism, and the gear blank is indexed; consequently, the tool passes through a succeeding tooth space each time it moves forward. Since the tool is slowly feeding in a lateral direction as though it were a rack in mesh with the gear being cut, the indexing movements exceed the circular pitch of the gear, just enough to com-

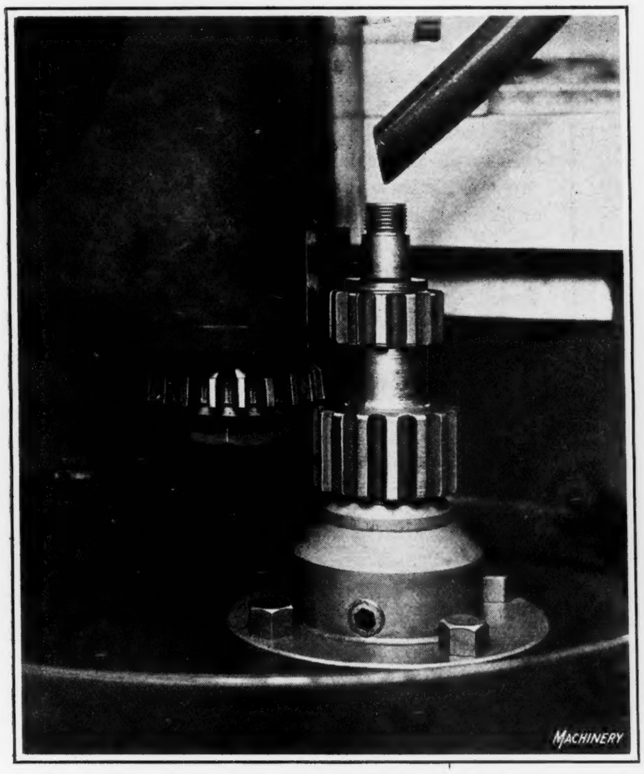


Fig. 4. Gear Shaper which is arranged for cutting on the Push or Downward Stroke of the Cutter

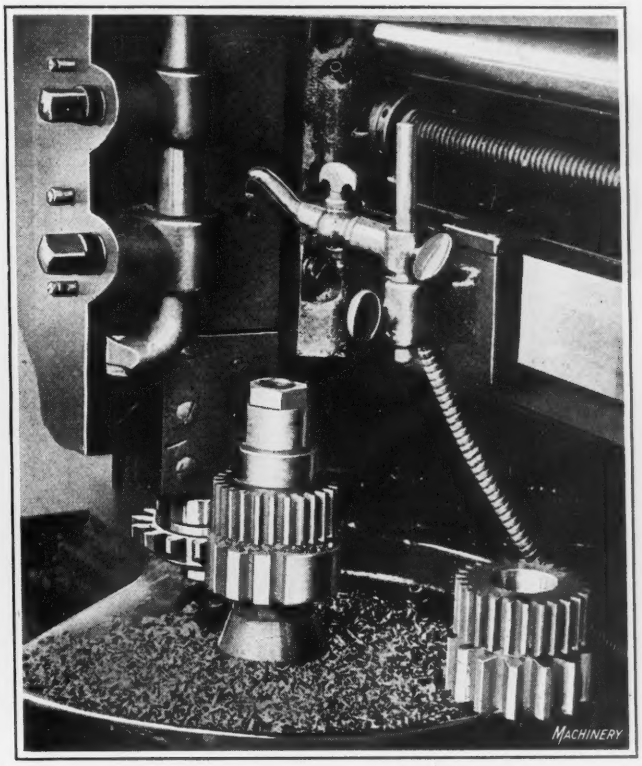


Fig. 5. A One-piece Double Gear cut by using the Pull Stroke for the Lower Section and the Push Stroke for the Upper Section

pensate for the lateral motion of the cutting tool. In other words, the gear blank is not only indexed relative to the pitch, but receives an additional rotary motion so that the tool and gear being cut act just as though a finished gear were rotating slowly in mesh with a rack, one tooth of which is represented by the tool. These rolling and traversing movements are controlled by change-gears selected according to the pitch. The lateral motion of the tool is obtained by the movement of slide *B* upon which the shaper mechanism is mounted. A cutter for a given diametral pitch is suitable for all numbers of teeth, which is true of any machine of the molding-generating type. Incidentally, the same machine can be used for cutting spiral gears, in which case the head carrying the work-spindle is adjusted about a vertical axis to conform to the helix angle of the gear to be cut.

Cutting Spur Gears on a Gear Shaper

When the teeth of spur gears are cut by a generating process on a machine which operates with a planing or shaping action, a gear shaper of the type shown in Fig. 2 is used in most shops. This gear shaper, made by the Fellows Gear Shaper Co., Springfield, Vt., is shown cutting two spur gears at the same time. The cutter has tooth outlines conforming to a gear of the same pitch as the ones being cut. This cutter is reciprocated vertically, and in starting to cut a gear it is first fed in to depth; then one gear tooth after another is formed as cutter and work slowly rotate together just as though two finished gears were in mesh. The action is illustrated by the diagram, Fig. 3. Successive positions of one cutter tooth are indicated by the succession of outlines. The feeding movement per stroke of the cutter will, however, be much less than the amounts shown by these outlines. As the tooth curves on this cutter are ground by a generating process after the cutter is hardened, very accurate gear teeth can be produced by this method.

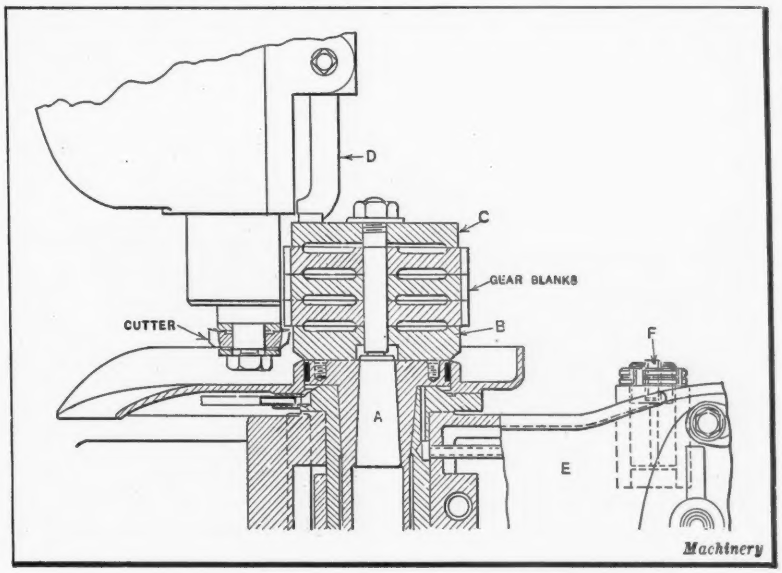


Fig. 6. Typical Method of holding Stack of Three Spur Gears

The gear teeth can be finished in one revolution of the gear blank, although a light finishing cut is often taken. In cutting transmission gears for automobiles, it is common practice to take a roughing cut followed by a light finishing cut. The machine may be arranged to take these two cuts automatically, but when gears are required on a large scale, it is generally considered preferable to use certain machines for roughing and others for finishing.

The rotation of the gear blank and cutter at the correct relative speeds is controlled by means of change-gears. When a machine has been properly adjusted for cutting gears of given pitch and number of teeth, all movements after starting the machine are controlled automatically. The gear blank is withdrawn from the cutter upon the return stroke to prevent dragging, the work-arbor being held by an apron actuated by a relieving mechanism. A cutter of given pitch may be used for any number of teeth of the same pitch, within the range of the machine, since this is a generating process.

Cutting during Upward or Downward Strokes

The cutter is ordinarily attached to the end of the ram with the cutting face upward or so as to cut on the pull or upward stroke. The machine in Fig. 2 is arranged so as to cut in this way. Sometimes there is not enough clearance to permit holding the cutter in

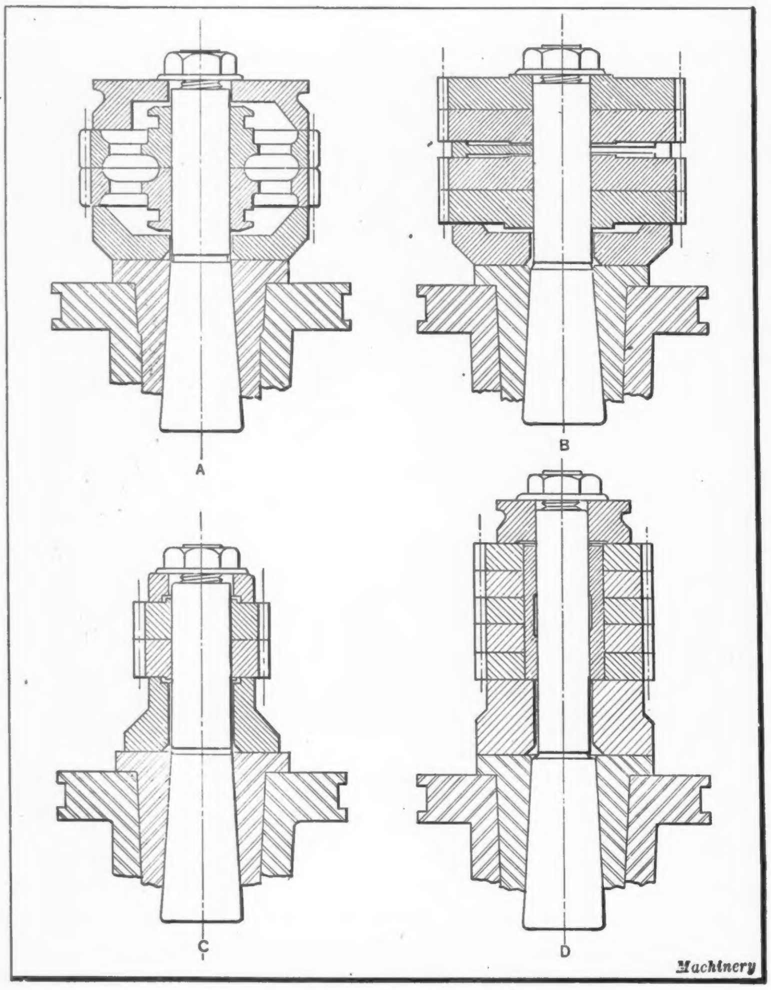


Fig. 7. Different Methods of locating and holding Spur Gears

this way, and then its position is reversed. For instance, this is done when cutting internal gears or whenever there is a shoulder or other part located close to the lower ends of the teeth. Fig. 4 shows a machine cutting a gear with the cutter reversed because of the small amount of clearance at the lower ends of the teeth.

The example shown in Fig. 5 illustrates how the gear shaper can be used to advantage when there is little clearance between two gears formed of one solid piece. In this particular instance, the manufacturing cost was greatly reduced by making the gear in this way. One side of this double gear is 10 diametral pitch, and the other side 5 diametral pitch. This double gear was intended for a cylinder boring machine, the object being to eliminate chatter. The teeth on one side are staggered relative to those on the other in order to split up the tooth action and secure smoother operation. The 10-pitch side of the gear was cut with the shaper operating on the push stroke, whereas the 5-pitch side was cut by means of the pull stroke. The illustration shows the machine cutting the lower side and operating with the pull stroke.

Methods of Holding Gears for Cutting

The simplest method of holding ordinary spur gears of the transmission type is shown in Fig. 2. The gears are mounted on a faceplate resting on the work-spindle, and they are located centrally by an arbor which also provides means for clamping. A similar arrangement is illustrated by the diagram Fig. 6, which shows a stack of three gears. The work-arbor *A* has a reverse taper, and is drawn up tight into the work-spindle when the nut at the top of the arbor is screwed down on the upper clamping plate. The gear blanks, together with the faceplate *B* and the upper plate *C*, are thus clamped rigidly against the end of the work-spindle.

Whenever practicable, the rigid work support *D* is used to take the direct thrust of the cut, assuming that the cutting is during the upward stroke. On apron *E*, which carries the work-spindle, there is a roller *F* for supporting a large faceplate, internal gears, or special fixtures for holding internal gears. Another roller held by a special bracket attached to the apron is used when it is necessary to locate the roller closer to the work-spindle, as when gears or fixtures of smaller diameters must be supported. The design of clamping plates or fixtures for holding either external or internal gearing is, of course, varied more or less to suit the shape and size of the work. A few examples illustrating different methods of holding and clamping will be described to show, in a general way, certain typical as well as more or less special applications.

Holding Gears Having Extended Hubs

Diagram *A*, Fig. 7, shows an approved method of holding sliding transmission gears having extended hubs. The two plates between which the gears are clamped are cupped out to provide clearance spaces for these extended hubs, and to permit the plates to bear directly against the gear rims. In this way, the gears are clamped just inside the root circle where support is needed, and as the lower plate rests directly on the flange of the work-spindle, the pair of gears is held rigidly.

Diagram *B* shows a method of holding gears having hubs which project slightly on one side only. In this instance four gears are placed on the arbor, and between each pair there is a spacing washer which clears the hubs but supports the gears close to the outside of the blank. The faceplate, resting on the work-spindle, is cupped out slightly to clear the lower gear blank hub. Diagram *C* shows an arrangement for two gears.

Arbor Bushings and Special Fixtures

Different sizes of bushings, adapters, or special fixtures are often used in conjunction with the central arbor, and some-

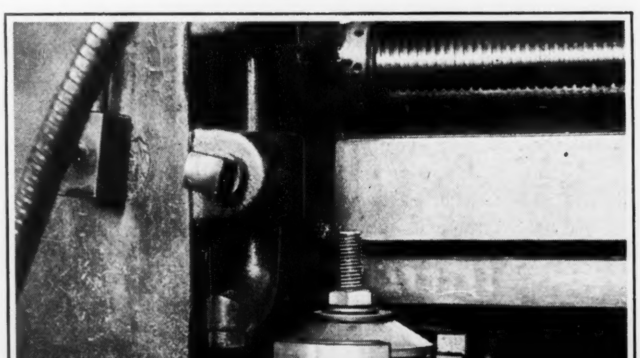


Fig. 8. Cutting Gear that forms Integral Part of a Sleeve and is Close to a Shoulder

times the latter is dispensed with, as, for example, when a gear has a long shank which must extend down into the work-spindle. Diagram *D*, Fig. 7, shows an approved method of holding a stack of gears when the holes are large enough to require a bushing on the arbor.

A type of gear which is rather difficult to hold is shown in Fig. 8. This gear is formed integral with a rather long sleeve, and it is also close to a shoulder, but the gear-cutting operation is readily performed on the gear shaper. The lower end of the sleeve is held in a centering bushing in the machine spindle, and the upper part in an adjustable fixture. Before clamping this fixture, it is centered by placing a dial indicator in contact with the bearing surface of the work. The latter is clamped down in the fixture by means of a bolt passing through the work-spindle. A slotted washer is used so that the work can be removed readily as soon as the nut is released.

Fixtures for Crankshafts with Integral Gears Located Close to Web or Shoulder

An example of work illustrating the application of the gear shaper to the cutting of gears having a small clearance space at one end is shown in Fig. 9. This gear is formed integral with a crankshaft. The lower end of this crankshaft is inserted in an adjustable fixture that is clamped on top of the work-spindle. The push stroke is used, and the crankshaft is stiffened by placing between the webs a small jack formed of a bolt and nut. Each crankshaft is located in the same position by means of a stop which comes into contact with the crank-pin.

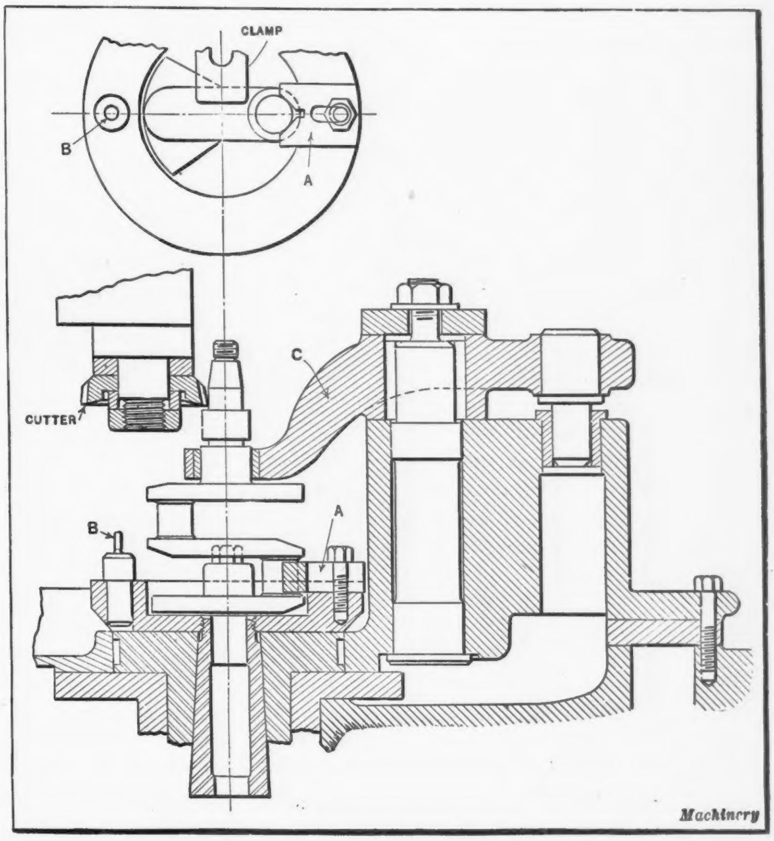


Fig. 10. Method of holding Crankshaft while cutting Gear Near Upper End

A more elaborate method of holding a crankshaft for a similar gear-cutting operation is shown in Fig. 10. The work is centered by a special hollow arbor held in the spindle by a faceplate. This faceplate carries a V-shaped locating stop *A*, and also a cutter locating pin *B*. This pin is required in order to locate the cutter in a certain position relative to the crank, because it was necessary to have the gear teeth in a certain relation to the crankshaft. After the cutter has been set, the V-shaped locating stop serves to hold each succeeding crankshaft in the proper position. The upper supporting arm *C*, containing a bushing which fits the shaft bearing, not only serves to center the upper end but also prevent excessive deflection of the shaft due to the thrust of the cut.

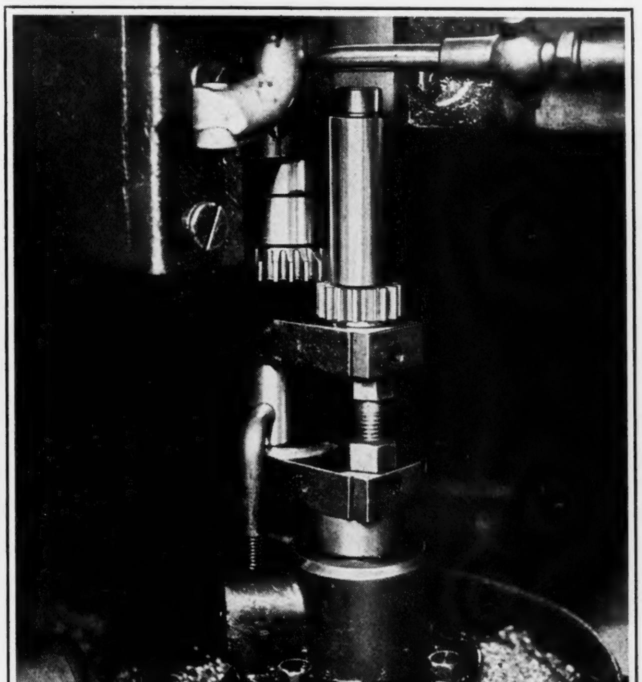


Fig. 9. Cutting Gear Teeth Close to Crankshaft Web, using Push Stroke

Cutting Spur Gears on Shaper of Multiple-tool Type

The usual method of cutting gears is either by forming one tooth or tooth space at a time, or by progressively cutting all of the teeth as the gear blank revolves to present the entire circumference to the cutting tool. Gang cutters which completely form more than one tooth at a time have been used to some extent, especially in connection with the formed milling cutter process. The multiple type of gear shaper developed by the Stevenson Gear Co., Indianapolis, Ind., is so designed that all tooth spaces may be cut at the same time, although for some classes of work it is considered preferable to cut, say, one-half or one-third the tooth spaces simultaneously. The usual method, however, is to equip the machine with as many tools as there are teeth in the gear to be cut, these tools being located radially around the circumference of the gear. When the machine is in operation, the gear blank (or blanks) is given a reciprocating motion past the cutting tools, which remain stationary except for a radial in-feeding movement which gradually sinks the cutters in to the required depth.

This is a formed-cutter process, the tooth spaces receiving their shape from the formed ends of the cutting tools. Each tooth space, however, is not formed by a single tool because the work is indexed after each cutting stroke. The object of this indexing is to equalize any slight irregularities which may exist in the different tools, thus making the teeth uniform in shape by causing each tool to operate in a succeeding space every stroke. To insure uniformity of tooth spacing, the tools are held at the full-depth position while the gear blank makes a complete revolution, thus permitting light finishing cuts to be taken. One or more gears may be cut at a time, depending on the face width of the blanks. The blank or blanks, as the case may be, are held on an arbor having a tapered shank which fits into the ram or

work-spindle. When cutting plain, external spur gears, usually from two to ten blanks can be placed on an arbor. As soon as the teeth are cut, this arbor is removed and replaced by one holding uncut blanks. This type of machine cuts gears rapidly, the actual cutting time varying from 1 to 4 minutes for an arbor of gears, the time depending upon the total face width and the depth of the teeth.

There are two different types of Stevenson multiple shapers, designated respectively as the "up-stroke" and the "down-stroke" types. The up-stroke machine is intended primarily for cutting plain spur gears, which can be passed through the tool-head, whereas the down-stroke type is designed more especially for cutting internal gears, cluster gears, or any form which will not pass through the tool-head. A detailed view of the up-stroke machine cutting a stack of spur gears is shown in Fig. 12. This is a view looking down on the cutter-head. The gears seen at the center are at the top of their stroke and the tools are largely concealed. In operating this machine, the changing of arbors involves stopping the machine, removing the arbor containing the cut gears by means of a foot-pedal, and dropping another arbor into place through the tool-head. In changing arbors on the down-stroke machine, which is illustrated in Figs. 13 and 14, it is necessary to stop the machine and then elevate the ram to provide additional working clearance so that the arbor may be dropped down and removed. After another arbor with uncut blanks is inserted in the spindle and fastened, the ram is lowered and the machine started. As this requires a somewhat longer time than changing arbors on the up-stroke machine, the latter type is preferable for the class of gears which it is adapted to handle.

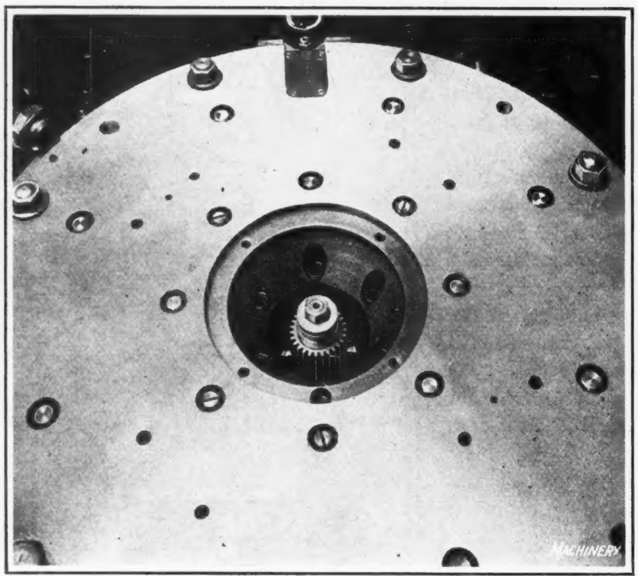


Fig. 12. Gear Shaper designed for cutting all of the Teeth in a Stack of Gears simultaneously

Each machine has two tool-heads, so that while one is in use, the tools in the other may be sharpened and reset. The outer end of each tool bears against a cam attached to a ring (see Fig. 14) which is given a slow rotary movement for feeding the tools inward, this motion being controlled through change-gears. As these cam sections are adjustable relative to the ring, the radial position of each tool can also be varied. After every cutting stroke the cam ring is given a reverse movement to withdraw the tool far enough to provide relief during the return stroke. During the cutting stroke the tools are clamped to hold them rigidly, and are released at the end of the cut to permit the relieving and feeding movements. The feeding movement is limited by an adjustable micrometer stop located on the tool-head.

The arrangement of the tools varies for different classes of work. For instance, the tool-head is sometimes provided with roughing and finishing tools located alternately. The roughing tools, which may either be of the "square-nose" or stepped form are adjusted so as to remove most of the stock. This combination of roughing and finishing tools is recommended for teeth coarser than 6 diametral pitch. Another arrangement consists in using a special cam which feeds a single finishing tool forward after the other tools have roughed out the teeth. Gang tools so formed that each tool cuts several teeth may also be used for the finer pitches.

* * *

The manufacture of automobiles is the third industry of the nation, according to the *Review of Industry*. Of the 10,000,000 automobiles that are now registered, more than 3,000,000 are said to be owned by farmers.

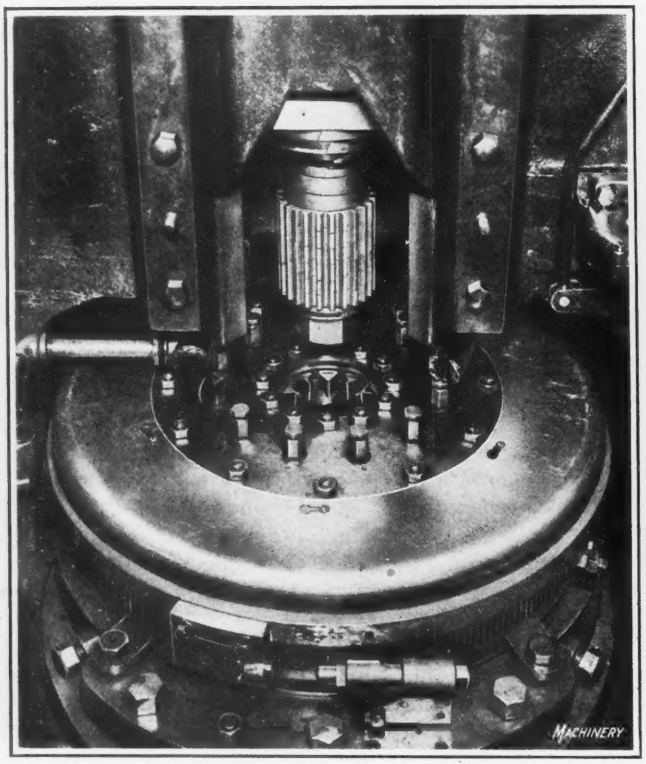


Fig. 13. The "Down-stroke" Type of Multiple-tool Shaper

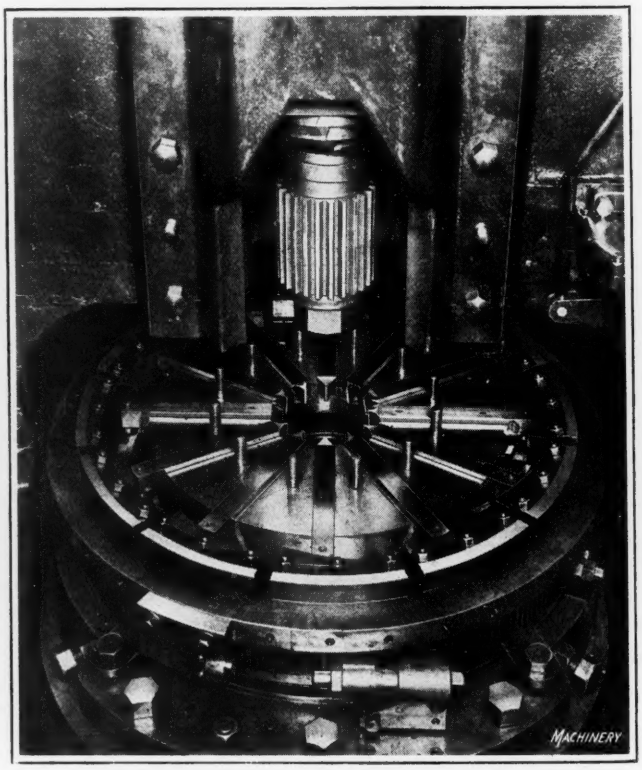
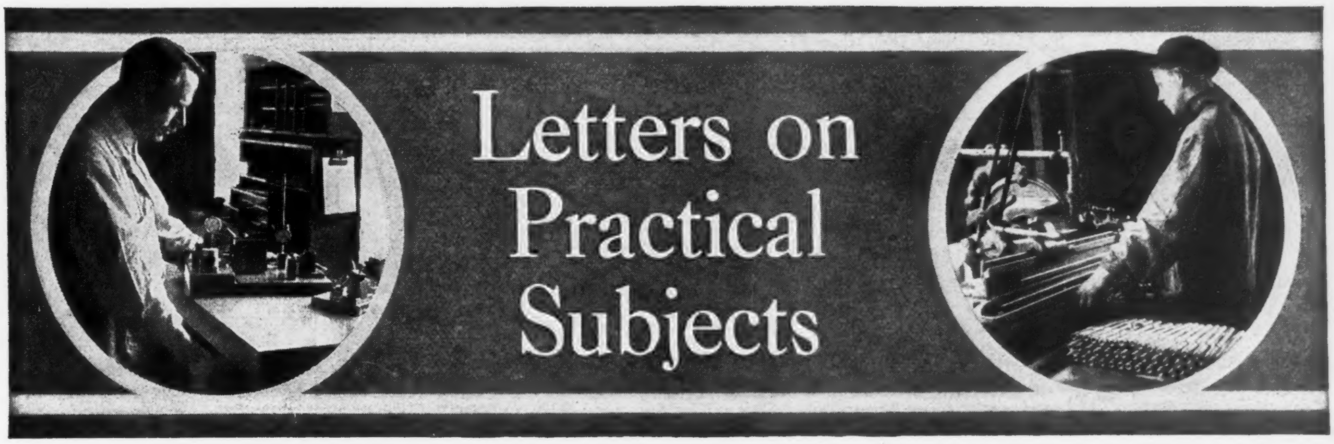


Fig. 14. Arrangement of Tools and Feed-cams on Multiple-tool Shaper



CENTERING DEVICES

The centering devices shown in the accompanying illustrations are being used in the screw product plant of the National Acme Co. at Cleveland, Ohio, for centering parts on a production basis in a hand screw machine. While these tools do not involve a strictly new principle, they nevertheless embody an adaptation of considerable merit, and they are daily increasing production fully 100 per cent over methods previously used. The possibility of adapting these devices to any production centering problem will be obvious.

In the plant referred to, which is devoted entirely to the production of screw products of the milled and upset varieties, much of the work intended for automotive and accessory construction must be heat-treated and ground. A considerable portion of this product consists of shafts, bolts, pins, and various special parts. These parts, upon leaving the automatic screw machine department, invariably require some secondary operation before heat-treating and grinding, and in addition, the cut-off end must be centered to facilitate holding during the grinding operation, if the nature of the part requires that it be held between centers.

The necessity of cutting the second center hole in the part in alignment with the first center hole and concentric with the periphery is readily understood. The centering tool shown in Fig. 1 is placed in the turret of a hand screw machine or in the tailstock of a lathe. This tool is intended for centering shafts or special parts of a similar nature which have a uniform diameter at and for some distance back from their uncentered end so that this portion can advance through the tool and up to the centering cutter the necessary distance.

The three rolls on the tool are adjusted by screws and lock-nuts to the diameter of the work. In addition, they are adjusted so that their contact points are at an equal distance from the center of the part so as to insure the proper location of the center hole. The rolls and pins on which they revolve are hardened and ground. A suitable centering cutter is placed in the holder and held firmly by a set-screw. The part to be centered is placed in the chuck and the turret advanced. The rollers receive the work, and revolving with it, guide it until the centering tool has cut to the required depth and the turret has been backed off. This tool has a range for centering work from $\frac{1}{4}$ to 1 inch in diameter.

The device shown in Fig. 2 is being used in centering parts which have, on their cut-off or uncentered end, a head or shoulder of a nature that prevents the part from entering and being guided by the rollers of the tool shown in Fig. 1. This device consists merely of a pair of hardened and ground rollers pivoted in a bracket which is fastened in the toolholder on the cross-slide of the machine.

The two rollers are brought forward by the cross-slide, which is adjusted to the proper height. They are then adjusted by screws and lock-nuts to receive or roll against the part to be centered. The part is placed in the chuck and the turret or tailstock equipped with a plain centering tool is advanced. The centering tool enters the work while it revolves against the guide rollers and in this manner is held true.

Cleveland, Ohio W. F. HONER

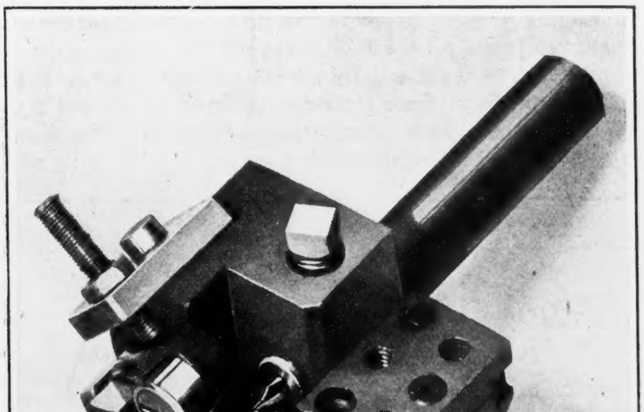


Fig. 1. Centering Tool provided with Guide Rolls

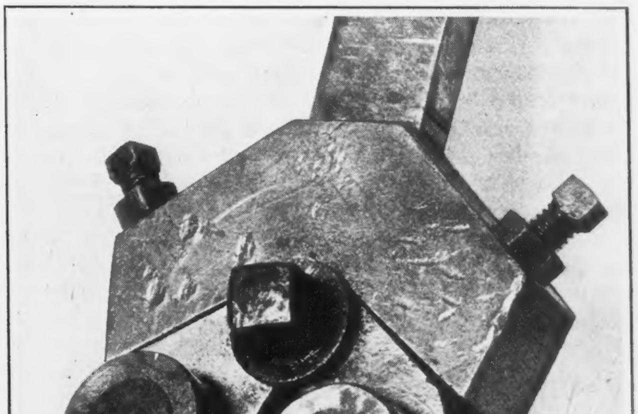


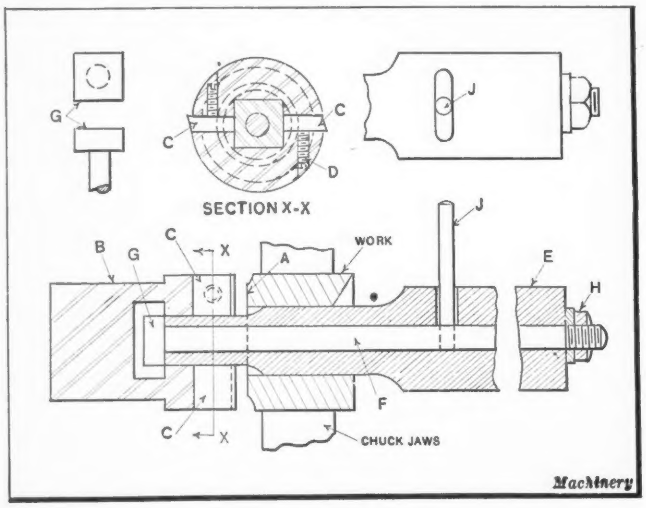
Fig. 2. Guide Roll Tool used in Centering Operations

BACK-FACING TOOL

The tool shown in the accompanying illustration is designed for back-facing surface *A* so that the work can be bored, reamed, taper-turned at the front end, and back-faced at one chucking in a hand screw machine. Part *B* is made a running fit in the spindle of the lathe, the front end having a square broached hole as indicated in the sectional view. The front end of part *B* is also slotted to hold two high-speed cutters *C*. A recess is cut at the back of the square hole, and the cutters are held in place by headless screws *D*.

The shank of part *E* is made to fit the hole in the turret, and the front end is turned to fit the reamed hole in the work. The front portion of this end is milled square to fit the square hole in part *B*. Part *E* is drilled through the center to receive the piece *F*, which has a square head *G* on the front end that is the same size as the square end of part *E*. Part *F* is threaded on the back end for a nut *H*. The body of part *E* is slotted to accommodate a lever *J* which is driven into a hole in part *F*.

The action of the tool is as follows: Part *B* is inserted in the spindle of the lathe, and the work gripped in a three-jaw chuck. After the boring, drilling, and reaming operations are completed, the back-facing tool is advanced, with lever *J* in such a position that the squared end *G* will be in line with the squared end of part *E*. When *E* has advanced far enough (as determined by a stop on the machine) to allow the square end of part *F* to enter the recess in part *B*, lever *J* is pulled over, which brings the squared end of part *F* out of line with the square hole in part *B*. The corners of the squared end *G*, coming in contact with the face of the recess in part *B*, permit the facing cutters to be brought into contact with the work by pulling the turret back. After the work has been back-faced, the two members *E* and *B* are disengaged by pushing lever *J* over to its former position, and withdrawing *E* from the work.

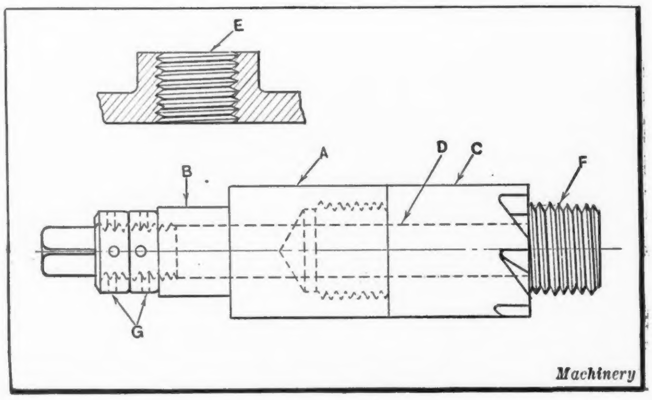


Back-facing Tool

HARRY MOORE
Rosemount, Montreal, Canada

FACING TOOL FOR SPARK PLUG BOSSES

Difficulty experienced in facing the spark plug bosses on automobile engine cylinder castings led to the development of the tool shown in the accompanying illustration. Referring to the sectional view above the facing tool, *E* represents the surface of the spark plug boss that is required to be faced square with the tapped spark-plug hole. In the view of the tool, *A* is a machine steel body having a 15/16-inch square section milled at *B*. A high-speed steel cutter *C* is screwed into the other end of part *A*. The threaded pilot *D* passes through cutter *C* and body *A*. The thread on the pilot end *F* is cut exactly the same size as that on the spark plug. A 3/8-inch square is milled on the left-hand end of pilot screw *D*. The pilot screw is made a slip fit in cutter *C* and body *A*, and is held in place by lock-collars *G*. To operate the tool, end *F* of pilot *D* is screwed into the tapped hole until the cutter *C* comes in contact with the spark plug boss. The tool and cutter are then revolved by means of a special wrench applied to the squared end *B* of body *A*. Another wrench is applied to the squared end of pilot *D* and manipulated to feed the cutter to the work, one-eighth turn being made to each revolution of the cutter. When the cutter has faced the boss to the required depth, the pilot is simply unscrewed from the hole.



Facing Tool for Spark Plug Bosses

Chicago, Ill. HAROLD A. PETERS

SPECIAL SCREW MACHINE CHUCKS

A chuck of unusual design, intended for use on a hand screw machine, is shown in Fig. 1. The object in designing this chuck was to retain the desirable features of the spring collet, with which the machine was regularly fitted, and in addition to provide a hardened and ground bushing for the purpose of piloting reamers and counterbores. The piloted tools were required in performing finishing operations on parts like that shown by the dot-and-dash lines at *A*, which were roughed out from brass castings in a preceding operation. The method of obtaining this combination will be seen in Fig. 1. At *B* is shown the chuck cap, and at *C* the collet retainer which is threaded into the cap to permit inserting the bushing or pilot guide *D*, the three segments of which are pressed into *C* with a light press fit. The spring collet *E* is milled out in three equally spaced sections to allow *D* to be located in the retainer *C* before the latter is screwed into the chuck cap *B*. This construction permits the guide bushing to be located close to the work.

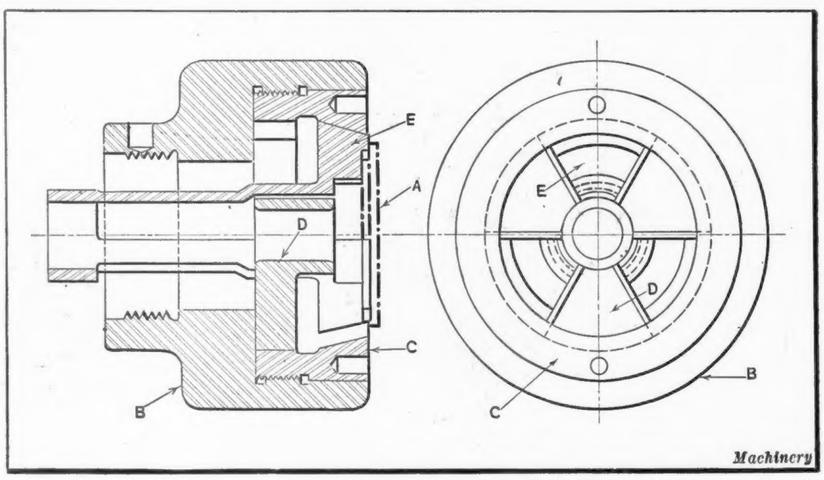


Fig. 1. Collet Chuck provided with Pilot Bushing

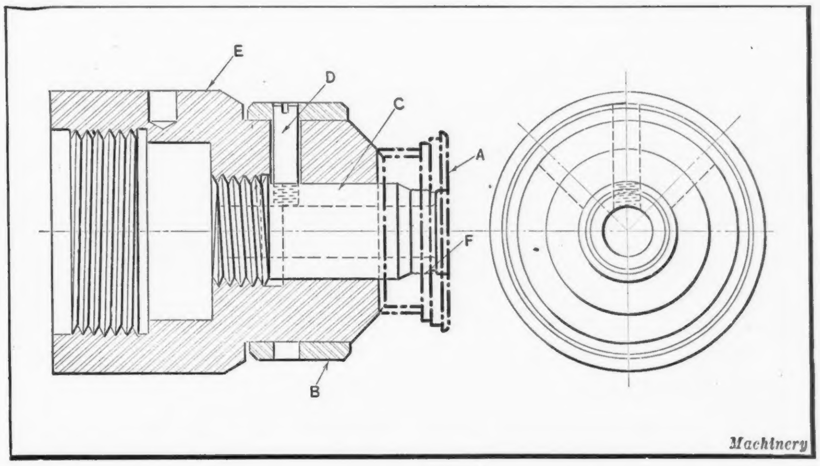


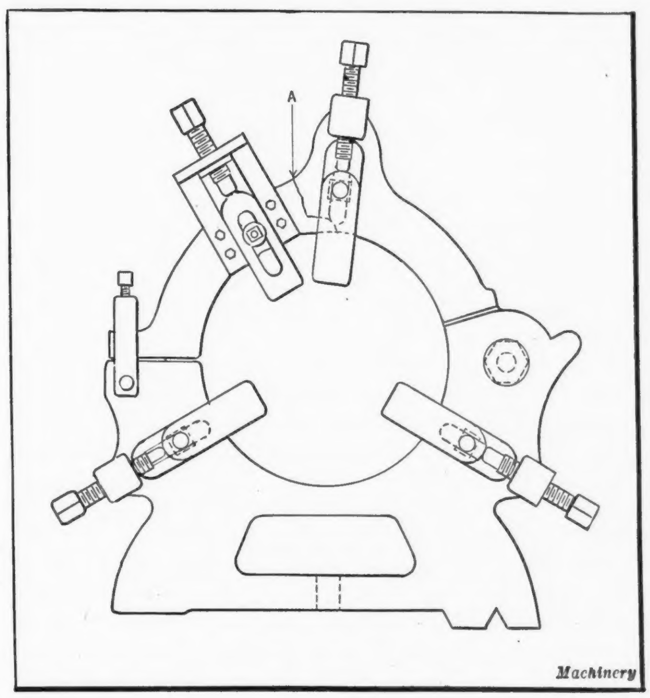
Fig. 2. Screw Chuck provided with Arbor and Pilot Bearing

The chuck illustrated in Fig. 2 was designed for the rapid production of the piece shown at *A*, which is required to be formed, faced, and counterbored with tools piloted in the work-arbor. The work is of brass, and the outside is required to be concentric with the hole at *F* in which a fine-pitch thread has previously been cut. The knurled operating ring *B* is connected to the combination arbor and pilot bearing *C* by screw *D* which passes through a slot in the chuck cap *E*. The work is clamped in place when the arbor is screwed into the chuck cap by rotating ring *B*, and although the cutting action may cause the work, with its fine-pitch threads, to tighten on the arbor, it may be readily removed without injury by unscrewing or loosening arbor *C* from cap *E* by operating knurled ring *B*.

Waynesboro, Pa. D. A. Nevin

STEADYREST FOR HEAVY PIPE

A length of steel pipe 6 inches in diameter having ¾-inch walls was to be cut into sections. The pipe was set up in a lathe, using a regular chuck and steadyrest. The cutting-off tool was held in a special holder which gave it great rigidity, but from the first it was apparent that the steadyrest was too weak for the job of cutting the heavy "stringy fibered" pipe. The tool finally stuck in the cut and the work "climbed," with the result that the steadyrest frame cracked close to the upper jaw on the broken line at *A*.



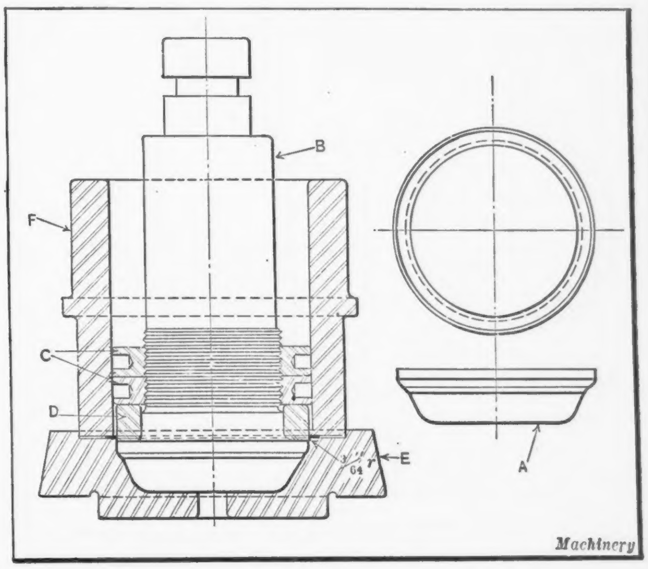
Steadyrest provided with Extra Jaw

The broken frame was welded, but it was obvious that some means of strengthening the steadyrest must be provided. A study of the work in motion showed that when the tool stuck, it acted as a pivot, so that the work was forced to "climb," thus exerting undue force on the upper jaw. The illustration shows how the trouble was remedied by providing an additional jaw at the left of the upper jaw. In this position it acted against the forces pushing the work upward, and allowed the work to be completed without further trouble.

Worcester, Mass. Roland Ljungquist

BLANKING, DRAWING AND CLIPPING DIE

In producing drawn sheet-metal parts that have to be trimmed or clipped, it is customary to blank and form the part in one operation and trim the drawn part in a separate operation. The punch and die shown in the illustration was designed to eliminate the second operation, so that only one operation is required to blank, draw, and clip the part.



Blanking, Drawing and Clipping Die used in Double-action Press

A double-action press of standard make, with a knock-out for ejecting the shell after the operation is performed, is employed. The shell shown at *A* is of sheet brass, 0.015 inch thick, and the blank diameter is 4.625 inches. The view at the right shows the shell after having been blanked, formed, and clipped. By referring to the illustration of the die it will be seen that the drawing punch *B* is threaded at the lower end, and that two check-nuts *C* hold the clipping ring *D* in place. The clipping ring should be 0.0015 inch smaller than the mouth of die *E*. In this instance, ring *D* and die *E* measure 3.4355 inches and 3.437 inches, respectively. To insure a good running fit, the blanking punch *F* should be bored to a slightly larger diameter than the check-nuts *C* which, in turn, should be from 1/64 to 1/32 inch larger than the clipping ring. The clipping ring is thus saved from unnecessary wear.

The radius at the mouth of die *E* is given as 3/64 inch, in this case, but it could be made as large as ¼ inch, if necessary, or as small as 1/64 inch, depending on which would work to the best advantage. In assembling the tools, clipping ring *D* should be so set that it will have trimmed the shell by the time that drawing punch *B* has reached its lowest position in die *E*, or within a distance from the bottom of the die recess equal to the thickness of the metal being formed, which in this instance is 0.015 inch. Some toolmakers call this the "pinch-off" method of clipping.

A die of the type described will increase production and therefore decrease the production cost. Dies of this type can be used satisfactorily on both sheet brass and steel. The wear on the tools is no greater than that on tools used to perform the same work in two separate operations. All the parts of the punches and dies are made of tool steel except the lock-nuts *C*, which are of machine steel. G. H. C.

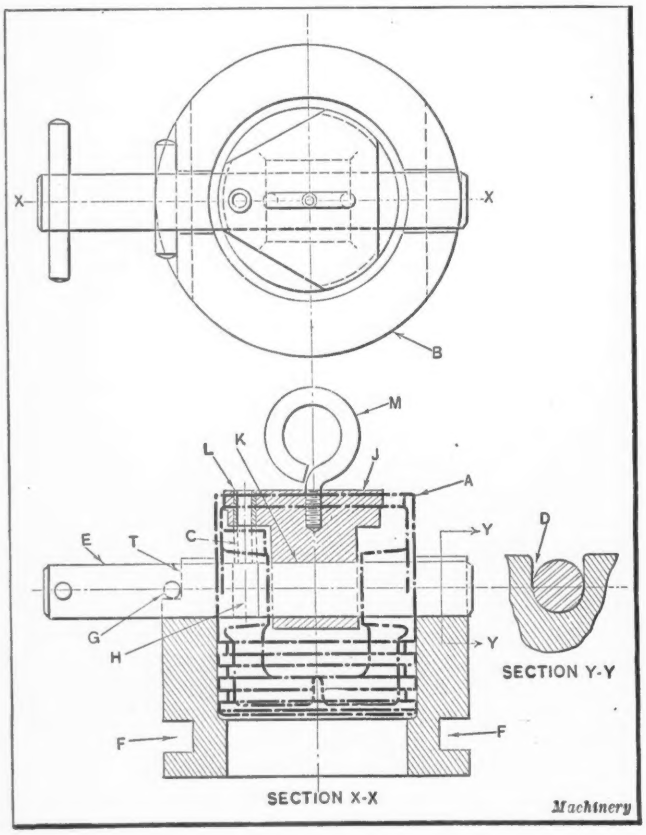
DRILL JIG FOR WRIST-PIN HOLE

The jig shown in the accompanying illustration is used for holding the engine piston *A* while drilling the wrist-pin set-screw hole at *C*. The body *B* is a round iron casting bored out to receive the piston after it has been ground on the outside. It also has a slot cut across the top, as shown at *D*, to receive the locating pin *E*. Slots *F* guide the fixture as it is slid from one spindle to another for drilling, spot-facing, and tapping the hole. The flat at *T* is used for locating the pin *E* by means of the cross-pin *G* so that the clearance hole *H* in the piston will be in line with the drill bushing *L*.

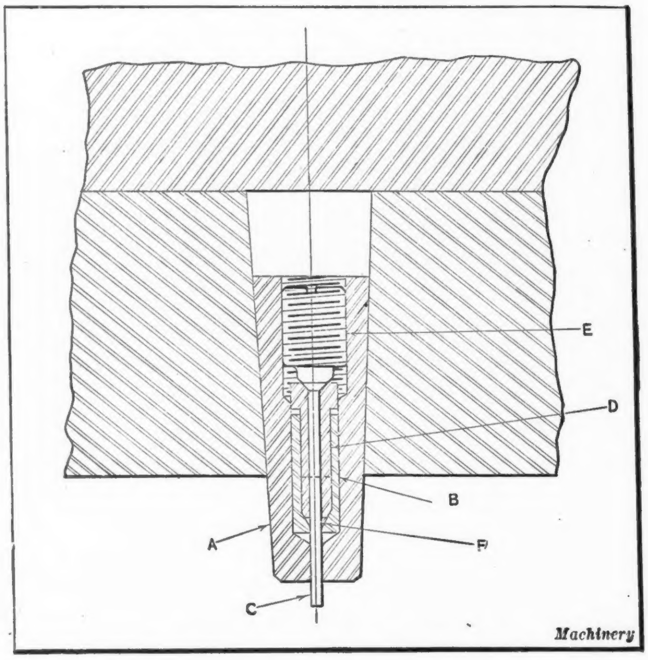
The bushing plate *J* is made of steel, and has a three-point bearing at the top that fits into the skirt bore of the piston, while at the bottom it has a ground hole *K* through which the locating pin *E* passes, lining up the plate *J*, ready for drilling the piston. The bushing plate is hardened and holds the drill bushing *L*. An eyebolt *M* is screwed into the top of plate *J* to facilitate handling. When using this jig, the bushing plate is dropped down into the piston and the locating pin *E* thrust through the wrist-pin hole, thus lining the plate up with the piston.

After this has been done the piston and plate are dropped into the jig body *B*, and the pin *E* pushed into the slots *D* and located by the flat *T* and the pin *G*. The hole is then drilled and the jig slid over to the next spindle. The pin *E* and plate *J* are next removed and the hole spot-faced, after which the jig is slid under the next spindle, where the hole is tapped and the piston removed from the jig. This jig has proved accurate and rapid, and has eliminated much wrist-pin locating trouble on the motor assembling floor.

Pittsburg, Pa. WILLIAM OWEN



Jig for locating Wrist-pin Set-screw Hole



Method of holding Small Piercing Punches

HOLDER FOR SMALL PIERCING PUNCHES

It is difficult to prevent the occasional breakage of small piercing punches, even when they are held in a rigid frame. Of the many holders that have come to the writer's notice, none seems so compact and rigid as the one shown in the accompanying illustration. This holder permits the punch to be easily replaced in such a manner that its location will not be disturbed. Thus all other subsequently pierced holes will be in alignment.

In the illustration, *A* is a punch-holder of any desired taper, which is driven tightly into the punch-plate. Part *B* is a hardened steel bushing which is a slip fit in *A*. The punch *C* is driven lightly into the holder *D*, which is slotted across the tapered end to give it spring, similar to a spring collet. Holder *D* is machined so that it will be a slip or sliding fit in *B*. Punch *C* is made of drill-rod so that it can easily be replaced in case it is broken, although breakage seldom occurs when a holder of this type is used. The upper end of the punch is riveted over, as shown, and retained by a set-screw *E*. When the set-screw *E* is tightened, the holder *D* is forced down against the angular surface *F*, thus gripping the punch *C* firmly.

Trenton, N. J. I. BERNARD BLACK

A PRODUCTION DRILL JIG

In the production of pieces having a drilled and reamed hole, it is customary to provide the drilling machine with a quick-change chuck and the drilling jig with slip bushings. For each piece completed, two changes of tools and two changes of bushings have to be made, and where only a short hole is to be drilled, a large portion of the operation time is consumed in changing tools and bushings. Fig. 1 shows a fixture for drilling and reaming a 3/8-inch hole through 3/4- by 5-inch steel pieces, in which the necessity of changing tools and bushings has been entirely eliminated.

The jig is used on a small drilling machine of the hand-feed type. The piece to be drilled is held in the V-block *B* by a clamping screw *C*, and is located by the stop-pin *D*. A large cast-iron sleeve *E* is made a good turning fit in the jig body and is held from axial movement by the nut *F* shown in the sectional view, Fig. 2. This sleeve carries two hardened tool-steel spindles *G*, located 90 degrees apart. One spindle carries the drill and the other the reamer. An index-plunger *H*, Fig. 1, secured to the sleeve *E*, permits either of the spindles to be locked in position over the work. The upper end of each spindle has two clutch teeth *J* that

match those in the hardened steel driver *K* which is held in the spindle of the drilling machine.

The teeth are so formed that their engaging sides form an angle of about 20 degrees with the vertical. Vertical movement of the drilling machine spindle automatically engages or disengages the tool-spindles. Thus the only movements required of the operator are the manipulation of the drilling machine feed-lever and the changing of the spindles *G* from the drilling to the reaming position by means of the index-plunger *H*. Hardened bushings *L*, Fig. 2, guide the drill and reamer. The lower portions of the spindles are made larger in diameter and are held in position by retaining straps *M*, Fig. 1. Light coil springs *N* and thrust washers *O* help withdraw the tools and hold them out of contact with the work while not being used.

A pilot *P* in the driver *K* enters a corresponding hole in the upper end of each spindle and helps to steady it. The driving teeth on the end of the spindles are made with inclined faces so as to cause them to follow the upward movement of the drilling machine spindle on the return stroke. A Graham shank twist drill is used, and is secured in the spindle by four headless set-screws, the points of which enter the two V-grooves in the drill shank. The reamer shank is made a loose fit in the spindle and is driven by a loose pin so that it has a chance to float slightly. By removing the screws *R*, the spindles may be taken out of the sleeve for inspection or sharpening of the cutting tools.

Obviously the use of such a fixture is not confined to the drilling and reaming of round work, as this type of fixture could be used equally well for drilling and counterboring work of any shape, drilling body and tap drill holes, and similar operations.

Meadville, Pa. H. H. MANNING

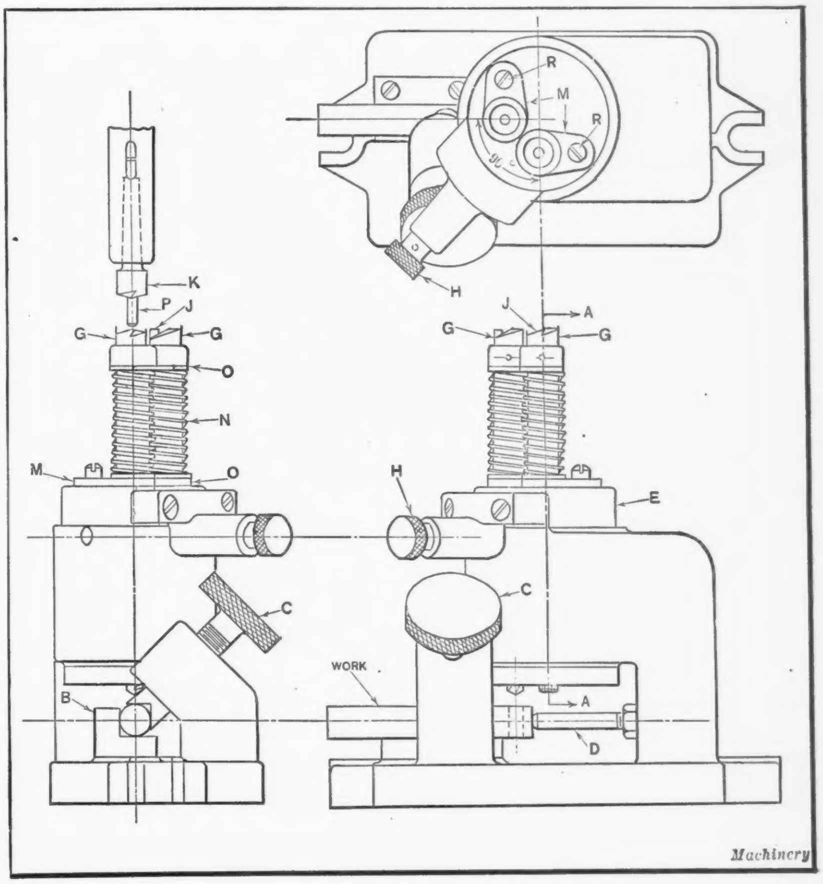


Fig. 1. Combination Self-contained Drilling and Reaming Jig

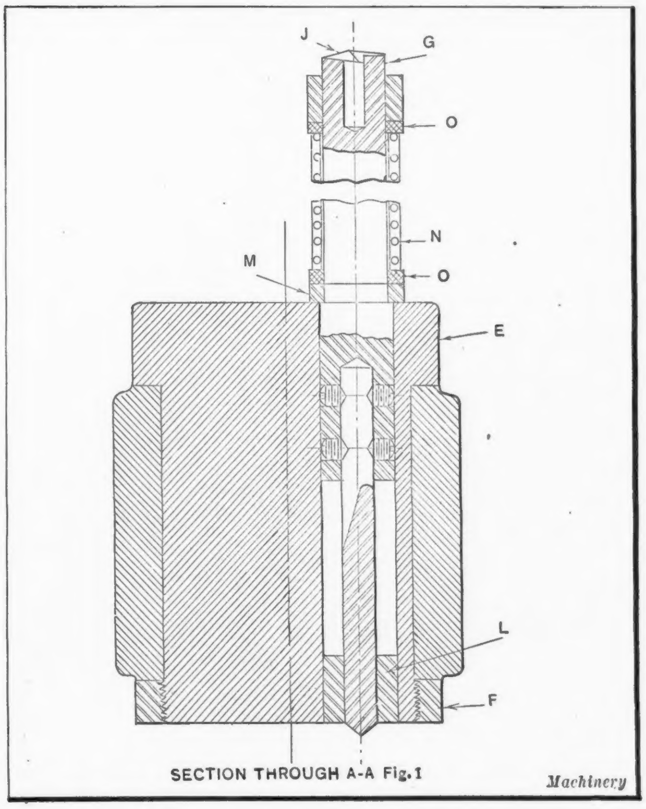


Fig. 2. Sectional View showing Drill Spindle Construction

SALVAGING WITH THE ACETYLENE TORCH

A concrete example showing the value of the oxy-acetylene torch for machine shop salvaging work is given in the following. In a large plant building a line of medium sized machinery and having its own iron foundry, a careful record was kept of every job for a period of about six weeks. This record was then used for calculating the approximate savings realized by employing the oxy-acetylene torch to repair defective and broken castings and broken parts of shop equipment. All costs for welding mixture and other incidental supplies were combined with labor costs to obtain the following figures, which show the result of the investigation:

Number of jobs	160
Total number of hours worked	290
Total weight of work repaired, in pounds	41,000
SALVAGE COSTS	
Welding mixture and incidentals	$450
Iron scrap (valued at $0.006 per pound)	246
Cost of remachining after welding	800
Wages of one welder and assistant (at a rate of $1.54 per hour)	447
Total cost of salvaging	$1943

As the total value of the product salvaged was $3400, the net saving is obviously $3400 — $1943 = $1457. Of the entire 160 jobs referred to, only 104 represented work done on the product, the other 56 being odd jobs such as cutting off material and making repairs to small tools and equipment, the cost of performing the latter work being included in the totals given. In calculating the value of parts salvaged, none of the equipment repair jobs were included, because the value of these miscellaneous items was difficult to determine. Account was taken of the value of parts only up to the point of breakage. It is evident then that had the savings in respect to tools and equipment been included, the item of net profit would be much larger than the amount recorded.

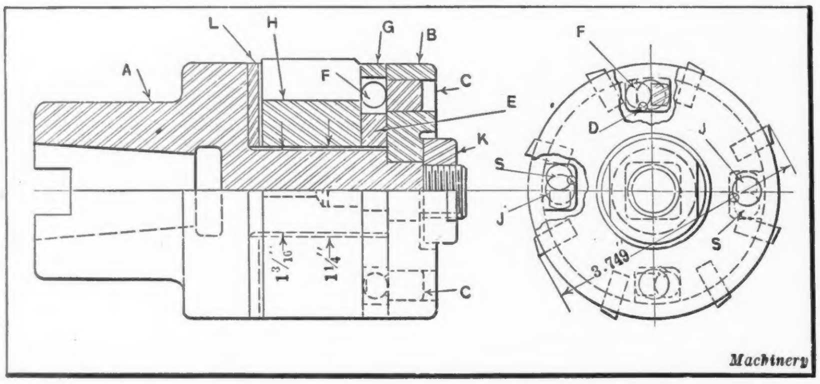


Fig. 1. Floating Reamer for reaming Automobile Engine Cylinders

The work on 76 out of the 104 parts repaired consisted of filling small blowholes and similar defects in castings that did not show up until the greater part of the machine work had been done. In the case of the other 28 parts, the repairs consisted of welding on pieces of flanges or other projections that had been broken off. All the jobs were relatively small ones, but nevertheless sufficient to make the part useless unless repaired, and these repairs could be satisfactorily accomplished only by welding.

In addition to the actual savings shown, many of the parts repaired were of such a nature that considerable and serious delays in production schedules would have resulted had it been necessary to recast and entirely replace them. It is hardly necessary to point out that a reduction in the number of defective castings and shop breakage is to be continuously striven for, but when one considers that the figures given here for the number of pieces repaired comprise but a fraction of 1 per cent of the total number of good parts produced, it is evident that no out-of-the-ordinary opportunities for using the welding torch were presented by the conditions under which the tests were made. The same possibilities exist in hundreds of other plants.

Cambridge, Mass. FREDERICK A. POPE

FLOATING REAMER

A "front-drive" floating reamer that has proved very satisfactory for reaming automobile engine cylinders is shown in Fig. 1. Some of the more important details of the reamer are also shown in Fig. 2, the same reference letters being used as in Fig. 1. The shank *A* is provided with a ground section 7/8 inch square which fits snugly into a square hole in the driving plate *B*. The driving plate has two tool-steel pins *C*, which are assembled in the plate and held in position by 1/8-inch pins *D*, while their projecting ends are milled to the shape shown in the detail view at *C*, Fig. 2. After the pins are machined, they are hardened and drawn.

The equalizing drive-plate *E* is provided with four equally spaced slots, the sides of which are ground where they make contact with the pins *C* and *J* and the 3/8-inch hardened steel balls *F* and *S*. A collar or ring *G* is pressed over the drive-plate *E* to retain the 3/8-inch balls.

The reamer body *H* is also provided with two pins *J* which are duplicates of those used in plate *B*. A nut *K* draws plate *B* up tight against the shoulder on shank *A*. In order to insure a good fit, or rather to allow the desired floating action, a thrust plate *L* is provided, which has three slightly raised portions on one face, as shown in Fig. 2. This plate is pack-hardened and ground to the proper thickness to compensate for any discrepancies that may exist in the thickness of the reamer body, driving plate, or length of shank. Details of the reamer blade used in the reamer body are shown in the lower right-hand corner of the illustration Fig. 2.

Lakewood, Ohio H. G. FRANTZ

* * *

STEEL TREATERS' SECTIONAL MEETING

A number of interesting papers were read before the New York sectional meeting of the American Society for Steel Treating, held at the Hotel McAlpin, New York City, on March 3. These papers included "New Developments on the Influence of Mass in Heat-treatment"; "Calite—a New Heat-resisting Alloy"; "Stainless Steel in Cutlery Use"; "Cold-headed Bolts—their Metallography and Heat-treatment"; "The Magnetic Testing of Small Casehardened Chain"; "Perfecting a Drop-forging"; and "The Manufacture of Steel." Several of the papers were illustrated.

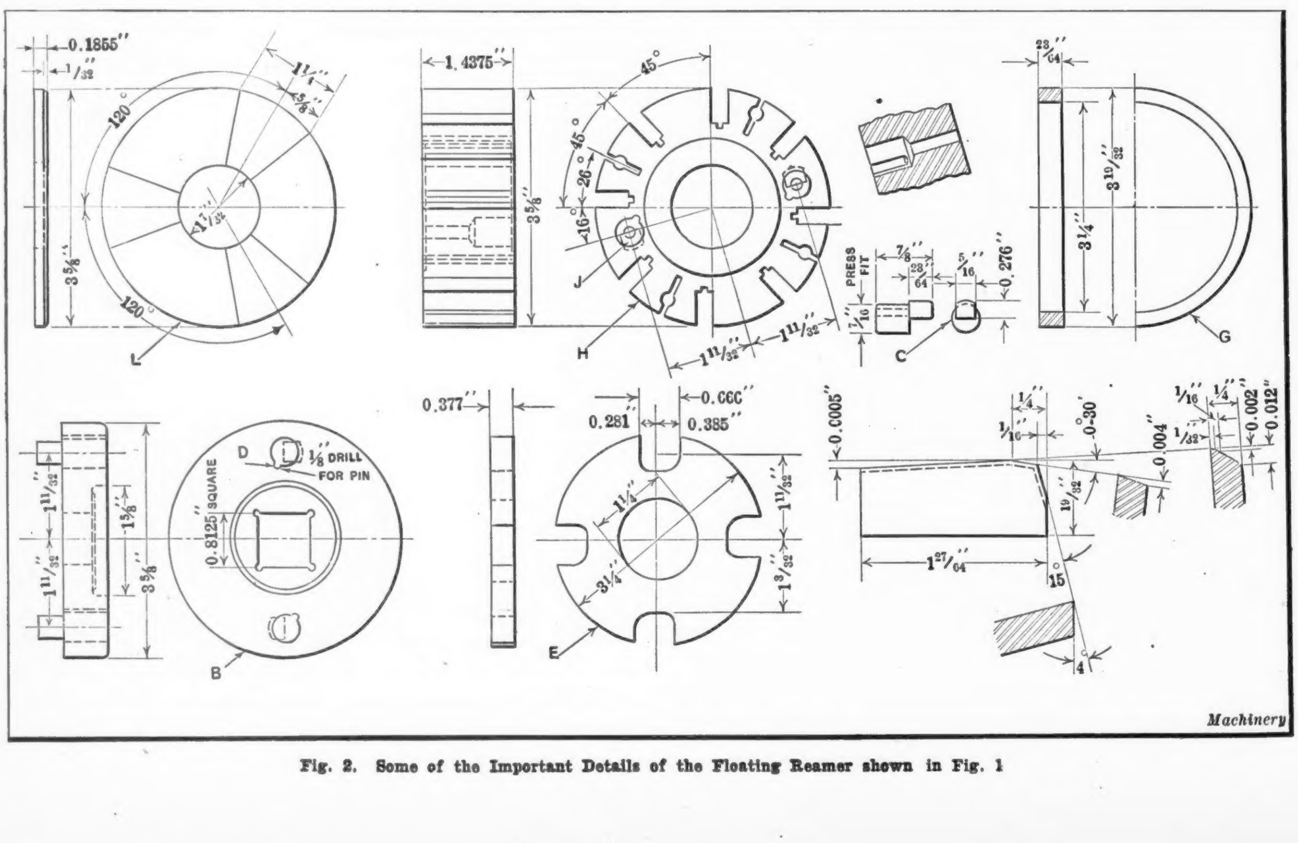
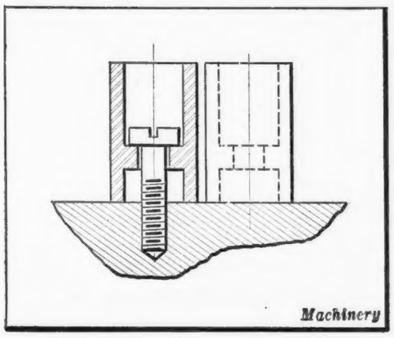


Fig. 2. Some of the Important Details of the Floating Reamer shown in Fig. 1

SHOP AND DRAFTING-ROOM KINKS

CENTERING AND LOCATING BUTTONS

The toolmakers' buttons shown in the accompanying illustration may be used to advantage when it is necessary to locate two or more buttons so close together that an indicator cannot be employed in the usual manner. Referring to the cross-sectional view, it will be noted that the button is counterbored to receive the head of the screw that is used to attach the button to the work. The counterbored hole is ground true or concentric with the outside of the button, so that the indicator contact point can be applied to the surface of the counterbored hole instead of to the outside of the button.



Centering and Locating Buttons

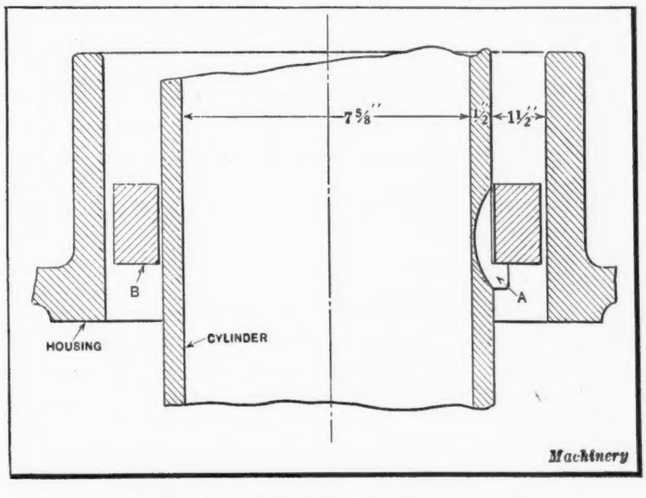
Ontario, Cal. CHARLES HOMEWOOD

SECURING COLLAR TO HOLLOW CYLINDER

The writer was recently confronted with the problem of securing a collar to the outside of a hollow cylinder in such a manner that it would withstand considerable end thrust, be easily and quickly removable in the direction of the thrust, and operate inside a circular housing which was concentric with the cylinder and 1½ inches from it all around as shown in the illustration. The use of set-screws or shoulders was out of the question, as screws could not be conveniently inserted or removed, and a shoulder would prevent removal of the collar.

Three keyways were finally cut, 120 degrees apart, on the outside of the cylinder, with a half-inch wide milling cutter. The gib keys, one of which is shown at *A*, were made with clearance enough to permit of their removal with the fingers or with a pair of pliers. To assemble the parts, collar *B* is pushed on the cylinder past the center of the keyways, the keys are inserted, and the collar drawn back over the keys until it rests against the gibs. To remove the collar the operation is reversed.

Montreal, Canada A. L. MORGAN



Method of securing Collar to Hollow Cylinder

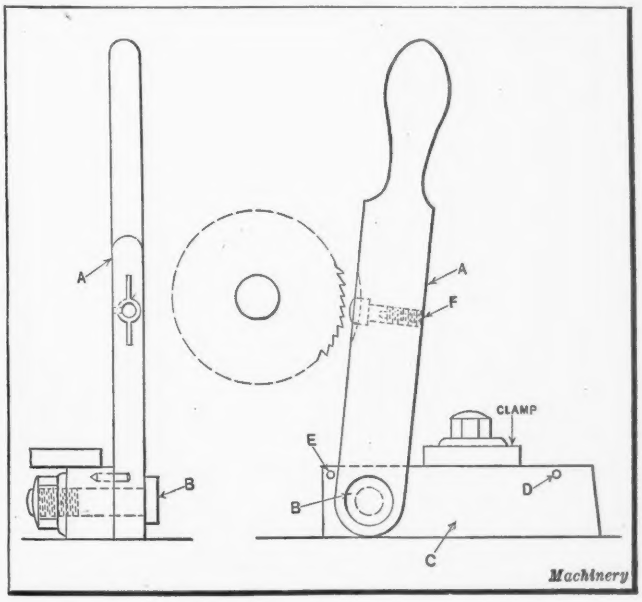
CENTERS MADE FROM DRILL SHANKS

The taper shanks of high-speed drills which are generally thrown away when the drills are worn out can be easily converted into lathe centers by hardening one end and grinding it to the required 60-degree angle. Centers made in this way are obviously inexpensive, and they will be found to give excellent service when used in lathes, grinding machines, etc.

Wilkinsburg, Pa. BERNARD E. LITOT

FIXTURE FOR SLOTTING SCREWS

A screw-slotting device which can be operated quite rapidly is shown in the accompanying illustration. The lever *A* is pivoted on the stud *B* held in base *C*. Lever *A* is drilled and counterbored to receive the screw to be slotted, the counterbore being deep enough to allow the screw-head to come about flush with the face of the lever. The screws can be slotted without chatter when held in this way. A pin *D*.



Screw-slotting Fixture

driven into the base, enters a slot *F* cut into the side of the screw hole in lever *A* and provides for ejecting the screw when the lever is brought down after the slotting operation has been performed. The pin *E* prevents lever *A* from being pushed too far forward, and thus eliminates the danger of cutting the slot too deep. The device is clamped to the saddle of a lathe, or if a small speed lathe is used it is clamped to the slide-rest.

Rosemount, Montreal, Canada HARRY MOORE

FASTENING HAMMER TO HANDLE

A method of fastening a hammer to its handle so that it will not come off is to first secure the handle to the hammer by means of three iron wedges set in the usual H form, and then boil the hammer and handle in linseed oil for several hours. A hammer thus treated has been in fairly constant use for thirty years without showing the slightest sign of coming off the handle. The handle is made of good hickory.

Wilkinsburg, Pa. WILLIAM S. ROWELL

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

PROBLEM INVOLVING VOLUME OF A CONIC FRUSTUM

A. R. I.—Can any reader of MACHINERY show how to find the depth of water in a tank which is in the form of a frustum of a cone, when the tank is only partly filled? If a tank is 9 feet in diameter at the top, 10 feet in diameter at the bottom, and 5 feet high, what is the depth of water when it is one-quarter full?

ANSWERED BY W. W. JOHNSON, CLEVELAND, OHIO

Referring to the accompanying diagram, let *ABCD* represent the vertical section of the given frustum taken

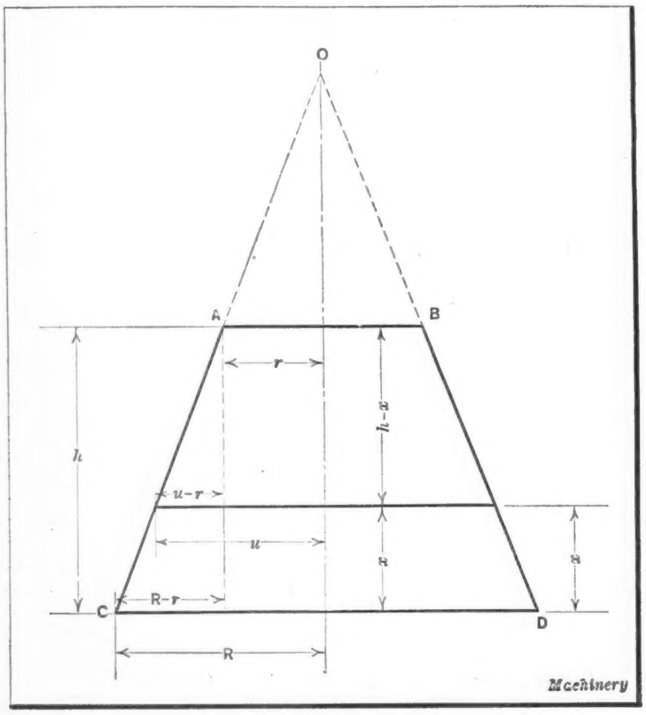


Diagram illustrating Solution of Tank Problem

through the center. Also, let r equal the radius of the top of the tank; R the radius of the bottom of the tank; h the height of the tank; n the number of parts in the total volume of the frustum, that is, the denominator of the fraction representing the part of the tank which is filled; and x the depth of water when the tank is $\frac{1}{n}$ full.

Denote the volumes of the three cones whose bases are circles having radii r, u, and R by the letters A, B, and C, respectively.

Then,

$$A:C = r:R \quad \text{and} \quad B:C = u:R$$

since corresponding volumes vary as the cubes of the radii or altitudes.

Therefore

$$A = \frac{r^3}{R^3}C \quad \text{and} \quad B = \frac{u^3}{R^3}C$$

Volume of water: volume of frustum $= 1:n$

Then

$$\frac{\text{Volume of water}}{\text{Volume of frustum}} = \frac{C - B}{C - A} = \frac{C - (u^3 \div R^3)\,C}{C - (r^3 \div R^3)\,C}$$

$$= \frac{R^3 - u^3}{R^3 - r^3} = \frac{1}{n}$$

from which

$$u^3 = \frac{R^3(n-1) + r^3}{n} \quad \text{and} \quad u = \sqrt[3]{\frac{R^3(n-1) + r^3}{n}} \qquad (1)$$

From the theorem of similar triangles,

$$\frac{u - r}{R - r} = \frac{h - x}{h} \quad \text{or} \quad u = R - \frac{x}{h}(R - r) \qquad (2)$$

Solving (1) and (2) for x, we find

$$x = \frac{h\left[R - \sqrt[3]{\dfrac{R^3(n-1) + r^3}{n}}\right]}{R - r}$$

Reducing all dimensions to inches and putting $n = 4$, $R = 60$, $r = 54$, and $h = 60$ in this formula, we find $x = 13.97$. Hence, the depth of the water when the tank is one-fourth full is 13.97 inches.

HEIGHT OF CREST ON WHITWORTH THREAD

H. H. G.—A lap is to be made for lapping the crests of Whitworth thread gages, and the height x (see accompanying illustration) must be determined. How can this be calculated?

A.—The vertical depth x from the crest of a Whitworth thread to the horizontal line intersecting the points where the crest and straight sides meet may be determined by the

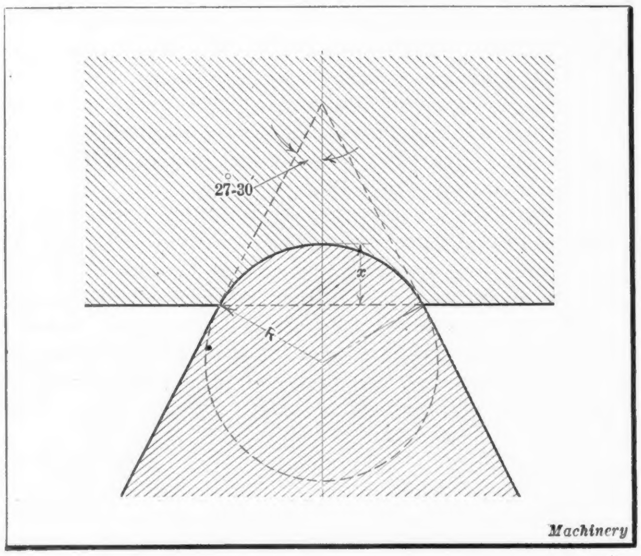


Diagram used in finding Height of Crest on Whitworth Thread

following formula, in which x equals the required height of the crest, and R equals the crest radius:

$x = R - R \sin 27$ deg. 30 min.; or $x = R - R \times 0.46175$

The radius $R = 0.1373 \times$ the pitch of the thread.

THREADED PIPE JOINTS

J. G. H. — What is the best material to apply to pipe threads before making up the joints in order to obtain a tight joint that will resist the action of gases or liquids?

A.—Red lead mixed with pure boiled linseed oil has been widely used and is very satisfactory. This mixture should have a heavy fluid-like consistency, and if applied to a clean, well-cut thread will give an excellent joint.

LOCATING A POINT ON THE HYPOTENUSE OF A TRIANGLE

F. I. D.—Referring to the illustration, *ABC* is a right triangle. Please show how to find distance x.

ANSWERED BY W. W. JOHNSON, CLEVELAND, OHIO

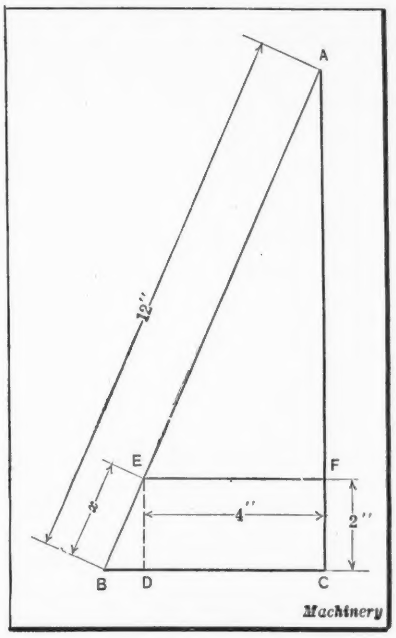


Diagram used in the Solution of a Trigonometric Problem

The triangles *AEF* and *EBD* are similar, as they are right triangles having angle *B* in common.

Hence,

$$\frac{EF}{AE} = \frac{BD}{EB}$$

Now, $EF = 4$ inches; $AE = 12 - x$; $BD = \sqrt{x^2 - 4}$; and $EB = x$. Then,

$$\frac{4}{12 - x} = \frac{\sqrt{x^2 - 4}}{x}$$

or

$$4x = (12 - x)\sqrt{x^2 - 4}$$

Squaring both sides and combining,

$$x^4 - 24x^3 + 124x^2 + 96x - 576 = 0$$

Solving this equation by Horner's method, we have

$$x = 2.1904 \text{ inches}$$

STANDARD ANGLES FOR RIVET HEADS

J. F. G.—Is there a standard angle for countersunk rivet heads, and does this angle vary for different classes of work?

A.—An included angle of 80 degrees has been adopted by the American Boiler Manufacturers Association for countersunk rivet heads, but this angle is not invariably used; for instance, the angle adopted by a prominent rivet manufacturer is 78 degrees. According to the handbooks of prominent steel manufacturers, an included angle of 60 degrees is the standard for bridge and structural work.

MASTER TOOL PROBLEM

L. M. S.—The profile of a master tool is outlined in the accompanying illustration. In making this tool, it is required to find dimension *AB*. Please show how dimension *AB* can be obtained when the known values are as follows: Angle *FEN* equals 40 degrees; angle *NEJ*, 60 degrees; diameters of circles *R* and *S*, 0.5 inch; dimension *DC*, 0.875 inch; *ED*, 0.125 inch; and radius *CT*, 1.375 inch.

ANSWERED BY GEORGE WARMINGTON BEVERLY, MASS.

First draw line *CK* parallel to *JE* making angle *HCK* equal to angle *NEJ*, or 60 degrees. Then draw line *AK* from *A* perpendicular to *KC*, and line *CL* from *C* perpendicular to *KC*, making *CL* equal to *JK*. Next draw line *CI* parallel to *EF*, making angle *ICG* equal to angle *FEN*, or 40 degrees, and draw line *BI* from *B* perpendicular to *CI*; also draw line *EM* from *E* perpendicular to *CI* and equal to *FI*.

$$CE = \sqrt{ED^2 + CD^2} = \sqrt{0.125^2 + 0.875^2} = 0.8839 \text{ inch}$$

$\cot PEC = 0.875 \div 0.125 = 7$ and $PEC = 8$ degrees 8 min.

As angle $LEP = 30$ degrees, $LEC = 30$ degrees $+ 8$ degrees 8 minutes $= 38$ degrees 8 minutes.

$$CL = CE \sin LEC = 0.8839 \sin 38 \text{ degrees } 8 \text{ minutes} = 0.8839 \times 0.61749 = 0.5458 \text{ inch}$$

Now

$$AK = AJ + JK = AJ + CL = 0.250 + 0.5458 = 0.7958 \text{ inch}$$

and

$$AC = 1.375 + 0.250 = 1.625 \text{ inches}$$

Then

$$\sin ACK = AK \div AC = 0.7958 \div 1.625 = 0.4897$$

and

$$ACK = 29 \text{ degrees } 19 \text{ minutes}$$

Also

$$HCA = HCK - ACK = 60 \text{ degrees} - 29 \text{ degrees } 19 \text{ minutes} = 30 \text{ degrees } 41 \text{ minutes}$$

and

$$HA = AC \sin HCA = AC \sin 30 \text{ degrees } 41 \text{ minutes} = 1.625 \times 0.5103 = 0.829 \text{ inch}$$

Also

$$HC = AC \cos HCA = AC \cos 30 \text{ degrees } 41 \text{ minutes} = 1.625 \times 0.86 = 1.3975 \text{ inches}$$

$$\text{Angle } ECG = 90 \text{ degrees} - PEC$$

Then

$$ECG = 90 \text{ deg.} - 8 \text{ deg. } 8 \text{ min.} = 81 \text{ deg. } 52 \text{ min.}$$

Also

$$\text{Angle } ECM = ECG - ICG = 81 \text{ deg. } 52 \text{ min.} - 40 \text{ deg.} = 41 \text{ degrees } 52 \text{ minutes}$$

$$EM = CE \sin ECM = CE \sin 41 \text{ degrees } 52 \text{ minutes} = 0.8839 \times 0.6674 = 0.5899 \text{ inch}$$

$$BI = IF - BF = EM - BF = 0.5899 - 0.250 = 0.3399 \text{ inch}$$

$$BC = 1.375 + 0.250 = 1.625 \text{ inches}$$

$$\sin BCI = BI \div BC = 0.3399 \div 1.625 = 0.2091$$

and

$$BCI = 12 \text{ degrees } 4 \text{ minutes}$$

Now

$$BCG = ICG + BCI = 40 \text{ deg.} + 12 \text{ deg. } 4 \text{ min.} = 52 \text{ degrees } 4 \text{ minutes}$$

and

$$BG = BC \sin BCG = BC \sin 52 \text{ degrees } 4 \text{ minutes} = 1.625 \times 0.7887 = 1.2816 \text{ inches}$$

and

$$GC = BC \cos \text{angle } BCG = BC \cos 52 \text{ degrees } 4 \text{ minutes} = 1.625 \times 0.6147 = 0.9989 \text{ inch}$$

Now draw line *BO* parallel to *EP* and *AO* perpendicular to *BO*. Then

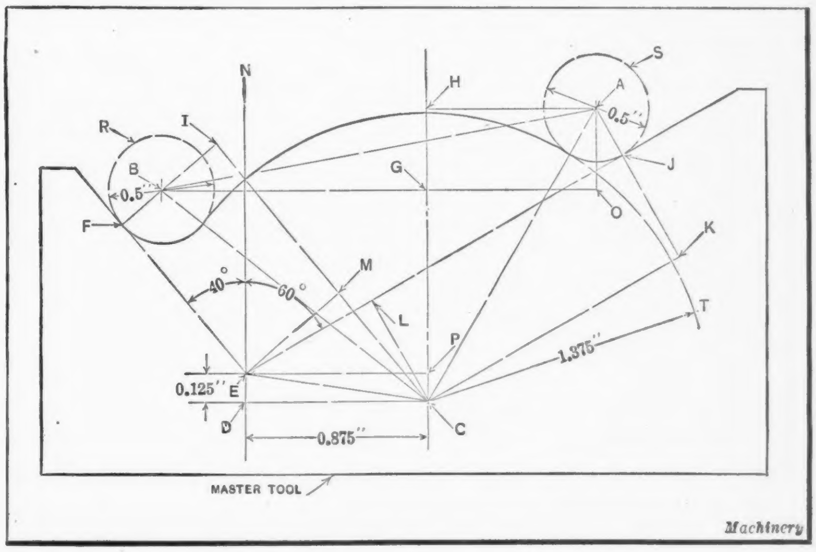


Diagram used in solving Master Tool Problem

$$AO = HG = HC - GC = 1.3975 - 0.9989 = 0.3986 \text{ inch}$$

and

$$GO = HA = 0.829 \text{ inch}$$

$$BO = BG + GO = 1.2816 + 0.829 = 2.1106 \text{ inches}$$

Therefore

$$AB\ \sqrt{AO^2 + BO^2} = \sqrt{0.3986^2 + 2.1106^2} = 2.147 \text{ inches}$$

Methods of Computing Pitch of Spur Gears

By GEORGE F. NORDENHOLT, Instructor in Mechanical Engineering, Lehigh University, Bethlehem, Pa.

With the exception of Equation (4), which was derived by the author, the methods of computing the pitch of spur gears, as here presented, were originated and developed by Professor P. B. de Schweinitz, of the Department of Mechanical Engineering of Lehigh University. The Lewis formula is employed in these formulas in such a way that they may be readily applied to the solution of spur gear problems without resorting to the cut-and-try methods commonly employed. The pitch obtained by the use of Formula (4) will be the smallest that may be used under the conditions specified and will accordingly result in the smallest gears permissible. In cases where the center-to-center distance of the shafts is not specified this is a distinct advantage.

The well-known Lewis formula for the computation of the pitch of spur gear teeth is often presented in the following form:

$$P = fpby \tag{1}$$

where

P = load on tooth;
f = allowable tooth stress;
p = circular pitch;
b = width of tooth; and
y = Lewis factor.

By means of simple algebra, the foregoing equation may be transformed to read:

$$p = \frac{P}{fby} \tag{2}$$

In designing gears, the ratio of the width to the circular pitch is always an important matter, and is chosen by the designer to meet the proper conditions, the usual value for this ratio being 2½ or 3. This ratio may be incorporated in the above formula by dividing the denominator on the right side of the equation by p and multiplying the left side of the equation by p also. If we then designate the reciprocal of the Lewis factor by c, we get

$$p^2 = \frac{Pc}{\dfrac{b}{p} \times f} \tag{3}$$

As c is determined by the number of teeth, and the number of teeth depends upon the pitch, it is evident that this equation could not be solved as it stands, except by a cut-and-try method. In order to eliminate this, substitute the term $\left(\dfrac{2\pi r}{z}\right)^2$ for p^2. This gives the equation

$$\frac{cz^2}{4\pi^2} = \frac{r^2 f \times (b \div p)}{P} \tag{4}$$

in which z = number of teeth in pinion; and
r = radius of pitch circle of pinion.

When the problem is to design a pair of gears to transmit a certain horsepower at a given speed and velocity ratio, and the center-to-center distance between the shafts is specified, the right-hand member of Equation (4) may readily be solved, basing all computations on the pinion, which, having the smaller number of teeth, will have the weaker tooth. In this case

$r = \dfrac{C}{R+1}$, in which R is the velocity ratio and C the distance between the shaft centers.

The value $\dfrac{b}{p}$ is chosen by the designer and P may be obtained from the formula $Pr = 63025 \dfrac{H}{n}$, where H is the horsepower transmitted, and n is the number of revolutions per minute of the pinion. The allowable tooth stress f may be the value recommended by Lewis, or it may be obtained by Barth's formula, or the Reuleaux formula. The accompanying table contains the reciprocals of the Lewis factor in the second column. The third column is the reciprocal multiplied by the square of the corresponding number of teeth, the result being divided by $4\pi^2$, thus giving $\dfrac{cz^2}{4\pi^2}$.

Having computed the value of $\dfrac{cz^2}{4\pi^2}$ from Formula (4),

TABLE OF GEAR CONSTANTS FOR 15-DEGREE INVOLUTE SYSTEM

No. of Teeth z	Reciprocal of Lewis Factor c	$\dfrac{cz^2}{4\pi^2}$	$2\pi c$	$\dfrac{2\pi c}{\sqrt[3]{720}}$	No. of Teeth z	Reciprocal of Lewis Factor c	$\dfrac{cz^2}{4\pi^2}$	$2\pi c$	$\dfrac{2\pi c}{\sqrt[3]{720}}$
12	14.90	54.4	93.6	10.43	45	9.25	474.4	58.1	6.49
13	14.10	60.4	88.5	10.10	50	9.09	576.6	57.1	6.37
14	13.30	66.0	83.5	9.30	55	8.93	684.2	56.1	6.26
15	12.80	73.0	80.4	8.97	60	8.85	804.5	55.6	6.20
16	12.30	79.8	77.3	8.62	65	8.77	939.0	55.2	6.16
17	11.90	87.1	74.8	8.35	70	8.74	1085.0	54.9	6.12
18	11.60	95.2	72.9	8.13	75	8.70	1239.0	54.7	6.10
19	11.40	104.2	71.6	8.00	80	8.66	1404.0	54.5	6.08
20	11.10	112.5	69.7	7.88	90	8.60	1764.0	54.0	6.03
21	10.90	121.8	68.5	7.64	100	8.55	2165.0	53.7	5.99
22	10.80	131.9	67.5	7.53	120	8.48	3093.0	53.3	5.94
23	10.60	142.0	66.6	7.43	140	8.40	4170.0	52.8	5.89
24	10.40	151.7	65.3	7.29	160	8.36	5420.0	52.5	5.86
26	10.20	174.6	64.1	7.15	180	8.32	6828.0	52.3	5.83
28	10.00	198.6	62.8	7.00	200	8.30	8409.0	52.2	5.82
30	9.90	225.9	62.2	6.93	250	8.25	13060.0	51.9	5.79
33	9.70	267.6	61.0	6.80	300	8.22	18736.0	51.7	5.76
36	9.50	311.9	58.7	6.55	Rack	8.06	a	50.7	5.65
40	9.33	378.2	58.6	6.53	...	....	....	....	....

Machinery

find the next smaller value in the table, and the number of teeth corresponding to it will be the maximum number of teeth the pinion should have. Dividing by the pitch diameter, gives the diametral pitch, from which the next lower standard diametral pitch may be chosen.

Solution when no Distance between Shafts is Specified

When no distance between the shaft centers is specified, the solution is as follows:

$$r = \frac{pz}{2\pi}$$

Then

$$P = \frac{Pr}{r} = Pr\,\frac{2\pi}{pz} \qquad (5)$$

Substituting this value of P in Equation (3), we obtain:

$$p^3 = \frac{2\pi cPr}{zf \times (b \div p)} \qquad (6)$$

As z may be chosen by the designer, $2\pi c$ is obtained directly from the table and the value of p can thus be computed, provided we are able to determine the proper tooth stress. To do this, we may use Reuleaux's formula,

$$f = \frac{S}{\sqrt[3]{V}} \qquad (7)$$

where S is the allowable stress for velocities up to 1 foot per second, and V is the velocity at the pitch line in feet per second. It should be noted that if V were less than one foot per second, f would be greater than S, which, of course, is not permissible. Hence if the velocity is equal to or less than one foot per second, S should be used in place of f, in Equation (6), and p may then be solved for. If the velocity, however, proves to be greater than 1 foot per second, we may substitute for V in Equation (7) its value $\frac{z\,p\,n}{720}$, and place this value for f in Equation (6), which, when solved to obtain p, results in

$$p^8 = \left(\frac{\dfrac{2\pi c}{\sqrt[3]{720}} \times Pr}{\dfrac{b}{p} \times S}\right)^3 \times \frac{n}{z^2} \qquad (8)$$

This equation may be solved from the data given, using the value of $\frac{2\pi c}{\sqrt[3]{720}}$ as given in the table.

Equation (8) has an added advantage in that even a considerable error made in computing the right-hand member of the equation is practically eliminated when the square root is taken three times consecutively in order to obtain the eighth root; for example, if the arithmetical work had resulted in $p^8 = 2088$, while the result should have been $p^8 = 6561$, then in the first case $p = 2.6$ while in the second case $p = 3$; both of which would call for a standard diametral pitch of 1¼. Even if the error makes the right-hand member come out within 200 per cent of what it should be, the final resulting error would be only about 9 per cent.

Having obtained the required standard diametral pitch, the diameter may be obtained by dividing the value of z used in solving Formula (6) or (8), by the diametral pitch obtained. After obtaining the diameter, the pitch velocity should be computed to make certain that the proper formula, either (6) or (8), has been used, which depends on whether the velocity comes out less than or greater than one foot per second. For instance if the velocity is thus calculated to be less than one foot per second it shows that Formula (6) is the correct one to use.

Comparison of Allowable Stresses

The value of S to be used in the Reuleaux formula may be the same as that used in the Barth formula. Up to a velocity of about 1.1 feet per second, the Reuleaux formula gives a higher unit stress. Then up to a velocity of about 14.2 feet per second, the Reuleaux formula gives slightly lower values for the allowable tooth stress. At a speed of 14.2 feet per second the resulting values are the same in both cases, while above this speed, the Reuleaux formula gives higher stresses. The accompanying chart shows a comparison of stresses when using the values recommended by Lewis and those obtained by the Barth and Reuleaux formulas.

It is not claimed that the Reuleaux formula gives more accurate results, but it is simple algebraically, which enables it to be combined with other formulas, as in the development of Formula (8). An attempt to use the Barth formula here would result in a very cumbersome equation, while the Lewis value could not be used at all. With slight modifications, and using mean values, the formulas here developed may be applied to bevel gears for the determination of the proper pitch.

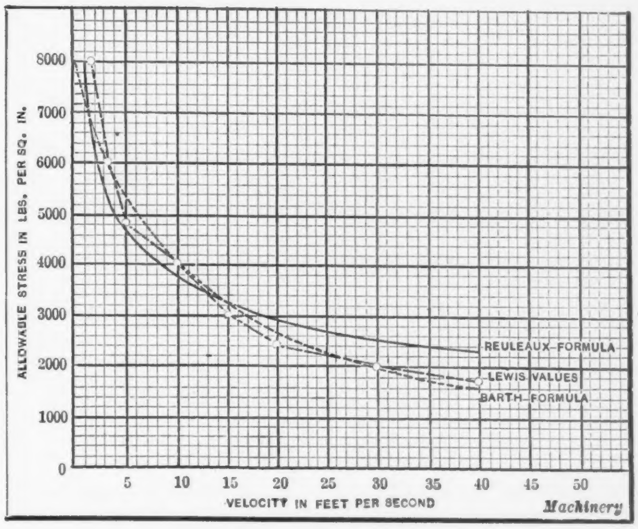


Chart showing Comparative Values obtained by Three Well Known Formulas, allowing an Initial Stress of 8000 Pounds per Square Inch in Each Case

Application of Formulas

The application of the method for computing the pitch of spur gears, as outlined in the foregoing is illustrated in the following examples:

Example 1—Given the center-to-center distance C between two shafts as 40 inches, and the revolutions per minute of the pinion and gear as 90 and 30, respectively; what should be the diametral pitch if 100 horsepower is to be transmitted?

$$R = \frac{90}{30} = 3 \quad \text{and} \quad r = \frac{C}{R+1} = \frac{40}{4} = 10 \text{ inches}$$

$$Pr = \frac{63025H}{n} = \frac{63025 \times 100}{90} = 70{,}000 \text{ (approximately)}$$

Also

$$P = \frac{Pr}{r} = \frac{70000}{10} = 7000$$

and

$$V = \frac{2\pi rn}{720} = \frac{2\pi \times 10 \times 90}{720} = 8 \text{ feet per second (approx.)}$$

Using Formula (7) and assuming that the allowable stress $S = 6000$ pounds per square inch, we have

$$f = \frac{6000}{\sqrt[3]{8}} = 3000 \text{ pounds per square inch}$$

Choosing a value for $\frac{b}{p} = 3$ and substituting the numerical values, we obtain from Formula (4):

$$\frac{cz^2}{4\pi^2} = \frac{r^2 f \times (b \div p)}{P} = \frac{100 \times 3 \times 3000}{7000} = 128.6$$

Referring to the table, it will be noted that the nearest value, less than 128.6 in the third column is 121.8. Hence the pinion may have 21 teeth, which will be equivalent to a diametral pitch of $\frac{21}{20} = 1.05$. The next lower standard diametral pitch is 1, and this pitch or any coarser standard pitch may therefore be used. Using a diametral pitch of 1, we would have 20 teeth in the pinion and 60 teeth in the gear.

Example 2—Four horsepower is to be transmitted from one shaft to another through spur gearing. The pinion is required to make 25 revolutions per minute and the gear 5 revolutions per minute. No center distance is specified. The gears are to be made of cast iron and as small as it is practicable to make them. Find the proper diametral pitch.

As the speed of the pinion is only 25 revolutions per minute, or less than half a revolution per second, we will assume that the peripheral velocity will be less than one foot per second, and hence base our calculations on Formula (6). To obtain the desired velocity ratio, we may use 12 teeth in the pinion, and 60 in the gear. Considering the tooth of the pinion, which is the weaker,

$$Pr = \frac{63025H}{n} = \frac{63025 \times 4}{25} = 10{,}000 \text{ (approximately)}$$

Referring to the table, we find that the value c for a gear having 12 teeth is 14.9, and $2\pi c = 93.6$

Now taking a value for $f = 6000$ and a value for $\frac{b}{p} = 3$ and substituting these values in Formula (6) we obtain,

$$p^3 = \frac{93.6 \times 10{,}000}{12 \times 3 \times 6000} = 4.33$$

$$p = \sqrt[3]{4.33} = 1.63$$

The nearest standard diametral pitch is $1\frac{3}{4}$. The pitch diameter would therefore be $12 \div 1\frac{3}{4} = 6.857$ inches, which gives a peripheral velocity of about $\frac{3}{4}$ feet per second, which is less than one. Therefore we were correct in using Formula (6). Had the velocity proved to be greater than one foot per second, we would have had to recalculate, using Formula (8) instead of Formula (6).

Example 3—The revolutions per minute of two shafts are to be 45 and 135, respectively. The horsepower to be transmitted is 100. The other conditions are to be the same as in Example 2.

Here the speed ratio is 1 to 3. As the velocities are considerable, it might be preferable to use gears having 15 and 45 teeth, rather than 12 and 36; the latter would be really smaller in diameter, yet they would probably not run as smoothly. The peripheral velocity may be assumed to be greater than one foot per second, as the pinion makes 135 revolutions per minute. Hence we will use Formula (8).

From the table we find that the value of $\frac{2\pi c}{\sqrt[3]{720}}$ for 15 teeth $= 8.97$

$$Pr = \frac{63025H}{n} = \frac{63025 \times 100}{135} = 47{,}000 \text{ (approximately)}$$

Take $\frac{b}{p} = 3$ and $S = 6000$,

Then from Formula (8), we get

$$p^3 = \left(\frac{8.97 \times 47000}{3 \times 6000}\right)^2 \times \frac{135}{225} = 7860$$

$$p^4 = \sqrt{7860} = 88.6 \text{ and } p^2 = 9.4 \text{ and } p = 3.06$$

The next larger circular pitch corresponding to a standard diametral pitch is 3.1416, which is a standard diametral pitch of 1. With 15 teeth, this gives a pitch diameter of 15 inches. The peripheral velocity of the gears would then be about 8.8 feet per second. As this velocity is greater than one foot per second, we were correct in using Formula (8). Had it figured out less, we would have had to recalculate, using Formula (6).

* * *

MAGNETIC TESTING OF DEPTH OF CASE

A demonstration of a magnetic method of determining the depth of case on small carburized and casehardened chain links was one of the interesting features of the recent New York sectional meeting of the American Society for Steel Treating. The demonstration was conducted by A. V. de Forest, research engineer of the American Chain Co., Bridgeport, Conn. The magnetic apparatus consisted of a simple form of inductance bridge operating on 60-cycle commercial current. The chain tested, which was made from wire ranging from 0.192 to 3/8 inch in diameter, is used as the cross-member of automobile tire chains, and consequently is subjected to wear from hard roads and from shocks produced by pounding over car-rails and cobblestones. If the case of the chain links is too thin, they wear out quickly, and if the case is too thick, they break in an even shorter time than it would take for soft links to wear out. It was to determine whether or not the depth of case is within the desired limits that the magnetic testing apparatus was developed.

The apparatus has a peculiar type of separately excited galvanometer which is used as an indicator, while a small rheostat and ammeter control the current operating the instrument, about 0.2 ampere at 110 volts being used. Resistance coils control the sensitivity of the instrument, and the deflections of the indicator can be adjusted to any desired limits. An adjustable resistance which balances the galvanometer is altered to compensate for different sizes of chain links or to change the scale of the instrument.

The magnetizing coil will operate on 1/16-inch wire, chain formed of 3/8-inch wire, or bar stock up to 1 1/4 inches in diameter. The outfit requires no setting up beyond connecting to an alternating-current lighting circuit. In testing a chain, several links are lowered into the magnetizing coil, the indicator of the galvanometer immediately moving across the dial and showing whether or not the depth of case is within the specified limits. Modifications of this apparatus would probably prove practical for testing other parts.

* * *

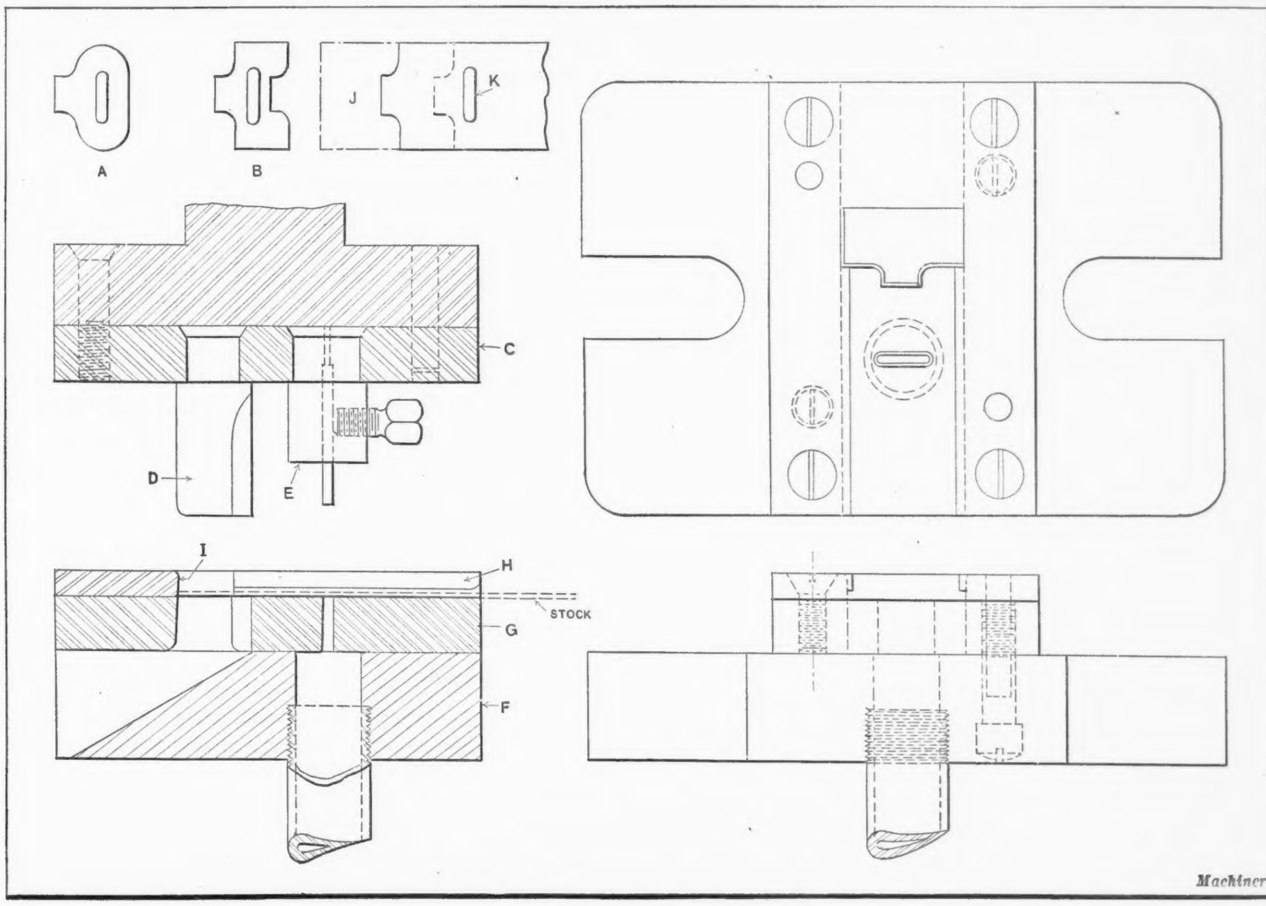
POWER TESTS OF A HEAVY LATHE

In order to determine the power and endurance of a certain type of lathe, the Houston, Stanwood & Gamble Co. recently conducted a series of tests on a 60-inch heavy engine lathe, driven by a Westinghouse 35-horsepower variable-speed motor. The results of these tests were as follows: At a speed of 15 feet per minute, and 1/4 inch feed, a huge steel roll was reduced 3 3/4 inches in diameter, the depth of cut being 1 7/8 inches. The ampere reading during the test showed that the motor was developing between 74 and 80 horsepower. Running the lathe at a higher speed of 35 feet per minute, with 1/4 inch feed, a depth of cut of 3/4 inch was next taken. The tests were completed by taking an eccentric cut, and one of the chips measured was found to be 1 1/2 inches wide and 1 inch thick. In view of the fact that the motor was greatly overloaded in each particular case, the cuts were run for short periods only. In some instances the motor was relieved of the extreme strain by passing a continuous spray of air through it.

FOLLOW-DIE FOR SHEET-METAL KEYS

By S. A. McDONALD

The accompanying illustration shows a follow-die designed by the writer for manufacturing box-opener keys. The original design of these keys was as shown at *A*, but it was realized that by changing the design slightly, considerable stock could be saved. Accordingly, the key was redesigned as shown at *B*, which enabled a simpler die to be constructed. The construction of the die is as follows: A machine-steel punch-holder carries the machine-steel punch-plate *C* in which the shearing punch *D* and the machine-steel punch-holder *E* are riveted. The shearing punch is shaped to the contour indicated at *J*, which represents the shape of the stock cut off from the end when first fed into the die, and this punch is hardened only on the front cutting edge. The tool-steel piercing punch is secured in the holder *E* by a set-screw, so that it can be easily removed for regrinding. The die-block or shoe *F* is made of machine steel, and supports the hardened tool-steel die *G*, which is fastened by screws and dowel-pins to it. The stripper plate *H* is a machine-steel member, and serves not only as a stripper, but also as a backing plate for the shearing punch *D*.



Dies used in making Key from Strip Stock

The stock is fed into the die until it abuts against the stripper plate at *I*. The shearing punch *D* then descends, cutting out the piece *J*, and at the same time the piercing punch produces the hole *K* in the strip. On the next downward stroke of the ram a second piece is blanked out without a hole, and it is not until the third stroke that a completed piece, as shown at *B*, is punched out. By providing a suitable stop for the stock, even these two pieces of stock could be saved, so that there would be no waste except the punching from holes *K*. The keys are pushed through the die and slide down the inclined surface of the die-block and into a suitable receptacle. The scrap from the hole passes through a tube screwed into the under side of the die-block. A press of the inclinable type was used, operating at 200 revolutions per minute.

REPRODUCING LARGE DRAWINGS

By H. R. BOWMAN

A slide-rule can often be employed to advantage in making small-scale reproductions or copies of large drawings for notebooks, record files, etc., when no great accuracy is required. In using the slide-rule, first find the over-all length of the drawing and determine the corresponding length of the small-scale drawing to be made, and set the slide-rule so that the graduations on the C scale representing one dimension will be opposite the graduation on the D scale which represents the other dimension.

This gives the proportion between the two drawings; for instance, if the length of the large drawing is 27 inches and the corresponding length of the small-scale drawing is to be 9 inches, the proportion would be 9 to 27, or the small drawing would be one-third as large as the original. The 9 on the C scale would be placed over 27 on the D scale, or 1 on the C scale over 3 on the D scale. As the ordinary slide-rule has an inch scale on one edge, it can be readily used to scale the dimensions on the larger drawing.

After locating the graduation on the C scale that is equivalent to the measurement taken on the large drawing, the corresponding dimension for the small drawing can be read directly opposite on the D scale. The writer has found this method a very convenient one for properly proportioning the lines on a small-scale drawing, especially where the scale of the smaller drawing is one not generally employed.

* * *

Firms who have occasion to employ the services of legal advisers in foreign countries will be interested to learn that the Division of Commercial Laws, Department of Commerce, is compiling a list of names of attorneys practicing in foreign countries who have been recommended by trustworthy sources as competent in their profession and in a position to care for American interests. These names will be furnished to American business houses on request.

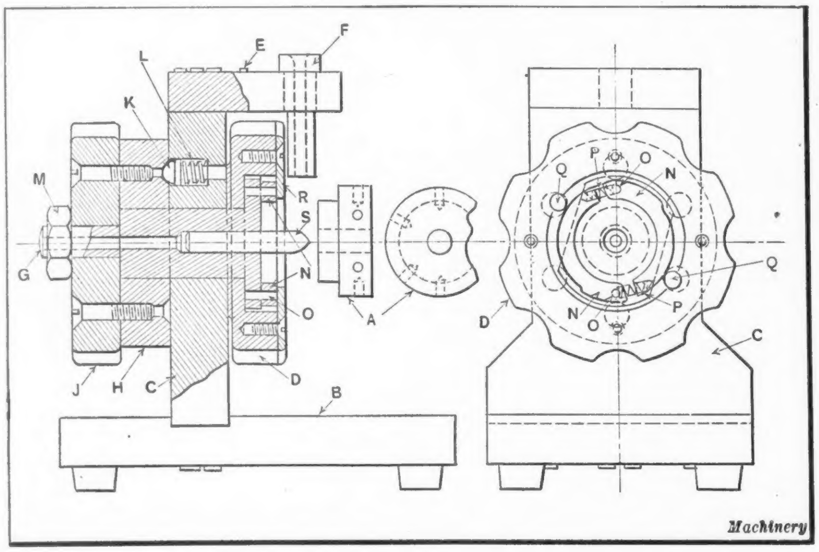
INDEXING DRILL JIG

By C. G. YOUNGQUIST

A quick-acting indexing drill jig designed to lower production costs is shown in the accompanying illustration. The work for which this jig was designed consists of drilling six equally spaced radial holes on the outer edge or circumference of an aluminum piece such as shown at *A*. The holes are required to be spaced quite accurately, as the drilled piece is made to serve as a sprocket by driving short pins into the holes. The fixture is mounted on a base *B* which has four short feet. An upright *C* is fitted into a slot in base *B*, and fastened by screws. Upright *C* is made narrower at the top so that handwheel *D* can be easily gripped.

A plate *E* carrying bushing *F* is fastened to the top of upright *C*. A shouldered stud *G* carries on one end the handwheel *D*, and on the other the index-plate *H* and the handwheel *J*. The latter is fastened to the index-plate by means of screws as shown. Both handwheels are notched so that a good grip can be obtained. The face of the index-plate in contact with upright *C* has six countersunk holes in it, equally spaced on a circular line. A plunger *K* engages the indexing holes, and is held against the plate by a coil spring *L*. The plunger has a half-spherical head and a shank of small diameter, and is made a sliding fit in a hole in upright *C*.

Both index-plate *H* and plunger *K* are hardened. Handwheel *J*, index-plate *H*, and stud *G* are held together by nut *M*. These parts, being rigidly fastened to each other, operate as one solid piece. Wheel *D* is counterbored to receive the head of stud *G* and the two clamping jaws *N* which swing on pins *O*, driven into holes in the head of stud *G*. The jaws are semicircular in shape and are located centrally from their inner surfaces; they are held apart by two small springs *P*. The springs are located in the holes drilled in the ends of jaws *N* as shown.



Indexing Drill Jig with Quick Loading and Unloading Features

The outside surface on each jaw is also semicircular, but is offset in such a way as to provide a clamping action when acted upon by pins *Q* embedded in handwheel *D*. Pins *Q* and jaws *N* are hardened. A guard plate *R* is fastened to the outside of handwheel *D*, to keep the chips out and to hold the jaws in place. The guard plate is omitted in the end view in order to show the chuck jaws more clearly. A locating pin *S* is driven into a reamed hole in stud *G*. This hole is extended through the stud to provide for driving the pin out in case this should become necessary.

The head of stud *G* is milled away on two opposite sides to give the necessary clearance for pins *Q*. The movement of handwheel *D* relative to stud *G* is limited by the clearance spaces milled on the head of stud *G*. In loading the jig, wheel *J* is held in a fixed position, while wheel *D* is turned to the left to give the jaws the largest possible opening. The work is then centered on pin *S*, and pushed up against guard plate *R*. Wheel *D* is then turned to the right until the work is securely clamped by jaws *N*. After drilling a hole, the drill is withdrawn and the wheel *J* turned until the spring-actuated plunger *L* is forced out into the next countersunk spacing hole in the index-plate *H*, which locates the work for drilling the next hole. This operation is repeated until the six holes are drilled. To obtain the best results, the jig is clamped in position on the drilling machine table and the drill set to the desired depth. The quick and effective loading and unloading feature of this jig, combined with the simple convenient method of indexing, not only resulted in lowering the production cost, but also made it possible to maintain a uniform quality of work.

* * *

BRITISH MARKET FOR SMALL TOOLS

According to a special report just issued to its members by the American Chamber of Commerce in London, there is practically no market for American small tools in Great Britain at the moment, but it is generally agreed that when trade becomes more normal, certain small tools, for which there was previously a good market will again be in demand.

The presence of large stocks in the hands of the government and dealers, and severe foreign competition aggravated by depreciated exchanges are the chief factors affecting American trade. In addition, the price of American precision tools has been considerably increased by the imposition of an import duty of 33 1/3 per cent owing to these tools being scheduled as a key industry under the Safeguarding of Industries Act.

The report further discusses the future position of American small tools, pointing out that in some instances American designs have been copied and are now being manufactured by British firms. Hints on marketing are also given, and American firms that contemplate entering the British market are advised to take up the question with the American Chamber of Commerce in London, which is always willing to give the benefit of its experience to such firms. Full details are available only in the report which has been circulated to members, but firms interested can secure copies by writing to the American Chamber of Commerce in London.

* * *

OBTAINING CHINESE TRADE

A forward-looking innovation in the development of foreign trade has been made by the South Bend Lathe Works, South Bend, Ind. This company has published an instruction book in Chinese containing eighty pages relating to lathe operation. The book is a translation of the company's well-known text-book, entitled "How to Run a Lathe," which has been widely distributed among trade schools. This is undoubtedly a step forward in the development of Chinese trade, because it is generally recognized that the manner in which this trade will be obtained is by American machinery gaining a place in Chinese trade and technical schools. In many instances the book contains the English names of machine tool parts and processes, doubtless because there is no equivalent word in the Chinese language, and before long these English words will be accepted and become incorporated into the Chinese language. The Far Eastern trade in machine tools has increased rapidly during the last ten years, and machine tool builders who keep in touch with the developments in that section of the country will doubtless find it worth while, even if immediate results should not be obtained.

TAPPING AND TAP DESIGN

By J. C. NICHOLSON

In tapping bottoming holes in cast iron, the use of a great amount of oil is objectionable. When too much oil is used, the fine chips or particles of cast iron invariably float into the spaces back of the cutting edges where the tap is backed off for clearance. These particles cause the tap to wedge in the hole as it is being backed out, making it more difficult to remove, besides causing the lands or clearance to be worn down more rapidly. If just enough oil to make a stiff paste of the chips is used, these difficulties will be avoided. The advantage of getting most of the chips out of the hole, thus leaving it clean for the part that is to be screwed into it, will also result from this practice.

The foregoing applies particularly to hand tapping, although it should not be disregarded in tapping by power. In the latter case, since the work is done more rapidly, more oil may be required to insure its reaching the right point soon enough to have the desired effect. In any case, however, cast iron requires but little lubricant when being tapped, and may even be tapped without it, though the practice is not recommended on all classes of work.

Tapping Holes in Steel

In tapping a bottoming hole in steel—particularly tough steel—the requirements are exactly the opposite. Here it is absolutely necessary that a copious supply of lubricant reach the cutting point. In order that it may do so, one of two courses must be followed: Either the tap must operate very slowly and be flooded with oil under pressure, or it must be stopped and backed up just a little at frequent intervals in order to allow the lubricant to reach the front of the cutting points. In tapping steel by hand, it is common practice with machinists to back the tap frequently until the chip is broken, the idea being that this allows the tap to cut more freely. The fallacy of breaking the chip may easily be proved by backing the tap only a very little at frequent intervals, putting no stress whatever on the reverse side of the lands. This allows the lubricant to reach the front of the cutting side of the lands where it is needed, and it will be found that the work proceeds just as well as when the tap is backed a sufficient amount to cause the back side of the land to shear off the chip. Breaking the chip does not help matters, and the lands were never designed for this purpose. It is evident therefore that the only useful purpose served by backing up the tap is that of permitting the oil to reach the proper place.

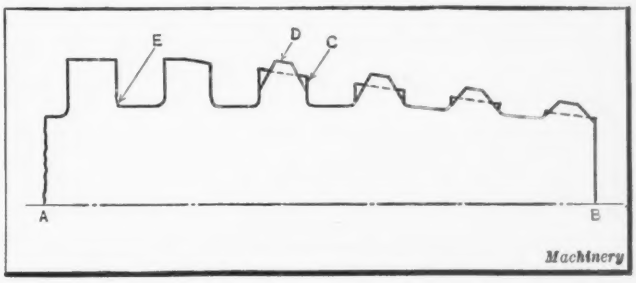
Of course, if a hole is very deep it may become necessary to remove the tap in order to clean out the chips that fill the flutes. In any case these chips will be found broken, and it is the breaking of the chips that consumes much of the power required for the tapping operation. Anything that obstructs the free movement of the chip—even at some distance from the cutting point—will have a decided effect upon the cutting action. If, for instance, in turning a shaft, some obstruction is placed squarely in the path of the chip, even though it is two or three inches from the tool point, the additional resistance to the chip will produce a noticeable effect on the work. The work will be left rough and the tool will heat more rapidly as a result of obstructing the chip. Of course, in the case of a tap, the chip is being more or less violently obstructed at all times—especially when tapping material that does not easily break in pieces—and this no doubt makes lubrication in such cases all the more necessary. The shape of the flute will, of course, have some influence on the cutting action.

Difficulty in tapping is sometimes due to the taps being so made that too little stock is removed by each cutting point. Many taper taps have a longer taper than is desirable for general use. A plug tap will often do the work from the beginning and operate almost as easily as a starting tap. The writer believes that taper taps in general would be improved by making the tapers about half as long as they are usually made. The practice of making pipe taps with half the cutting points removed is excellent.

Tool for Tapping Square Threads

In tapping square threads in steel there is a tendency for the chip to bind in the groove, which often results in breaking the tap. A tap made as described in the following will effectively overcome this difficulty. Referring to the accompanying illustration, *AB* is the center line of the tap. The tap has four flutes, and as far as the tapered portion extends, two opposite lands have threads of truncated V-shape as shown at *D*. The other two lands have square threads as shown at *C*. The last few threads on the tap are all alike, thus insuring the finishing of the thread to the correct size and form. In the illustration two adjacent lands are shown superimposed one upon the other in order to indicate more clearly how the tap is made.

It will be seen that for most of the tapered distance the diameter across the truncated V-lands is greater than that of the other two lands. The truncated points will therefore cut deeper than the square ones, thus leaving a slight V-thread in the bottom of the square thread, so that as the succeeding square points begin to cut, the chip will be in



Tooth Profiles of Tap used for cutting Square Threads

two parts. This prevents the objectionable binding in the grooves previously mentioned. For instance, as the tap is turned to the right, land *D* takes a cut of truncated V-form, while land *C* following this cut removes metal only at its corners.

The taper and other features are purposely exaggerated in the illustration in order to make clear the principle involved. The tap is made by first cutting a square thread having the same taper and diameter as the truncated lands. After it is fluted, two of the opposite lands have the threads formed to the shape indicated at *D*, while the other two are made as shown at *C*. This work may all be done with a file, since uniformity is unimportant and in fact undesirable in many cases. A tap of this design was thoroughly tried out in tapping nuts for pipe wrenches. Although the pipe wrench nuts were made from tough steel, the tap cut rapidly and produced accurate threads when used with a drilling compound as a lubricant. The corners at the bottom of the tap thread are filleted slightly, as shown at *E*. In this way all burrs were removed from the nut so that the thread was left smooth.

* * *

It has been asserted that one of the causes of high railway rates is the large salaries paid to executives of the road, and that the first step in decreasing expenses should be to reduce these salaries. In this connection the following facts, taken from the *Review of Industry* are illuminating. If all salaries of general officers of steam railroads in the United States in 1920 had been abolished, rates and fares could not have been reduced as much as 1 per cent. If the total of all general officers' salaries of 1920 had been added to the employes' payroll for that year, it would have increased the men's wages only 1.3 per cent. It will be seen from the foregoing that the item of salaries of general officers in such an extensive business as railroading is not a major part of its expense.

The Machine-building Industries

IT is gratifying to be able to report a slow but definite improvement in the metal-working industries. This improvement is especially noticeable in the automobile manufacturing districts of Michigan, northern Ohio and Indiana, and in the Ohio and Pennsylvania iron and steel districts. The demand for standard lines of machine tools is still very small, but a majority of the machine tool builders we have seen state that their sales for the last three months exceed the sales for any similar period during the last eighteen months. The demand for special and single-purpose machine tools, on the other hand, is increasing to a considerable extent. Several of the makers of machine tools of this type say that their February business was 50 per cent, or more, of the average for the first three months of 1920, which has been taken as a basis of comparison by the National Machine Tool Builders' Association.

Another indication of increased activity is found in shops specializing in pressed parts, especially in the Central States, where several shops are running at 100 per cent capacity, one, at least, even employing a night shift. The tool and contract shops in and around Detroit, Toledo, and South Bend—the centers where the automobile business shows the greatest activity—also report a satisfactory volume of business, but competition is keen and prices consequently very low. Other evidences of increasing business in the machine-building field are improvements in the sales of ball bearings and better business in bearing bushings for machine tools and other lines of machinery.

General Conditions in the Machine Tool Industry

It is impossible at this time to make a general statement about conditions and prospects in the machine tool industry that would cover the industry as a whole. Conditions vary greatly according to locality and lines of machines manufactured. Some manufacturers report that during the last two months there has been a very active demand for gear-hobbing machinery and for small electrical grinders. In the lathe field the demand has been mainly from technical and trade schools, and four orders are under way for over forty machines each from this source. But on the whole the current trade school's demand for machine shop equipment has been somewhat overestimated because of the relatively light demand for machines for general industrial purposes.

The garage and repair shop demand for machine tools is still fairly active, but price is so important a consideration that some machine tool builders are considering building cheaper tools than their standard products in order to meet the specific needs of the repair shop.

Although the demand for standard types of machine tools has been quite small during the last year, the industry as a whole is in a healthier condition than it was a year ago. Early last summer most of the manufacturers ceased adding to their stocks, and the total stocks of practically all standard tools are materially reduced, compared with last June. In the case of upright drilling machines, present stocks are only 60 per cent of what they were nine months ago.

Taking Care of Excess Plant Capacity

Many machine tool manufacturers are turning to other fields of machine-building and metal-working as an outlet for their excess shop capacity. It is generally recognized that plant capacity in the machine tool field is from 30 to 40 per cent in excess of probable requirements for several years to come. This excess capacity is being gradually utilized for other purposes. Pistons, piston-rings, woodworking machinery, foundry machinery, bakery machinery, excavating and road-building machinery are among the lines upon which machine tool builders have entered, in addition to those previously mentioned in MACHINERY—laundry and domestic washing machines, printing presses, motorcycles, automatic refrigerators, automatic ice-cream freezers, etc.

The machine tool industry has gradually adjusted itself to the reduced volume of business that seems inevitable during the next two or three years compared with the war period. Some of the firms doing from 50 to 60 per cent of the business of the peak period have accepted this as normal business, and others now doing 30 per cent of their peak business figure this to be 50 per cent of a normal business. Many machine tool builders have so reduced their greatly expanded overhead and their organizations that they are able to make a profit when operating at 30 per cent capacity, and some have readjusted their business to a pre-war basis. These steps are even more important for the healthy advancement of the industry at the present time than an increasing volume of business. The heaviest drag on the industry has been the war-time overhead which was out of all proportion to the demands likely to be placed on the industry within the near future.

Prices of machine tools have been reduced by many makers to a definite low level, and it would undoubtedly be for the benefit of the entire industry if all manufacturers would definitely determine upon selling prices that can be maintained, and then adhere to those prices without deviation. The uncertainty as to prices that exist in some lines of machine tools retards the resumption of buying.

Reduced Costs Due to Improved Machine Tools

In this review in March MACHINERY several examples were given showing how costs have been reduced by the application of modern machine tools. Other examples have come to MACHINERY'S attention offering comparisons of unusual interest. In one case an automobile manufacturer employed eight machines of a standard type, working two shifts and requiring sixteen operators, the production being 50 pieces in 22 hours. The cost of the machine and tool equipment was $26,000. This equipment was replaced by a single-purpose machine occupying considerably less floor space, which requires only four operators, working in one shift. The cost is only $11,000 and the production 63 pieces in 9 hours.

In another case two machines and two men produced 25 pieces per hour, while a new machine requiring but one operator produces 37 pieces per hour. The cost of this machine is $2300, and the direct saving is $1800 a year.

The Automobile Industry

It is frequently stated that the automobile industry is operating at from 50 to 60 per cent capacity, but it is also generally conceded that the normal demand on the industry for some years to come will not be materially above 60 per cent of the total output capacity of existing automobile plants. Hence many of the plants that now operate at from 60 to 75 per cent capacity might well be said to operate at a normal rate of output. The competition in the automobile field is very keen, and certain standard makes of cars appear to have taken a definite lead over their competitors, by reducing costs and prices to the lowest practicable levels. Some of the leading plants are carefully and thoroughly revising their manufacturing methods, and are installing machinery that will reduce costs.

The substance of this month's review of the machine-building industries is that the period of decline is definitely ended, the heavy liquidation is about completed, and the slow climb upward has really started.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

The New Tool descriptions in MACHINERY are restricted to the special field the journal covers—machine tools and accessories and other machine shop equipment. The editorial policy is to describe the machine or accessory so as to give the technical reader a definite idea of the design, construction, and function of the machine, of the mechanical principles involved, and of its application.

Walsh Power-press Push or Pull Feed

AUTOMATIC feeding of stock of various widths on any make of power press may be accomplished by means of a mechanism now being placed on the market by the Walsh Press & Die Co., 4709 W. Kinzie St., Chicago, Ill. An application of this mechanism is illustrated in Fig. 1, and a close-up view of all members except the connecting-rod and eccentric crank is shown in Fig. 2. The casting on which the members shown in Fig. 2 are mounted is attached to the bolster plate of the press by means of four cap-screws which pass through slots in the casting. This method of attachment permits shifting the cap-screws to suit the holes in a bolster plate.

Power for the mechanism is derived from the eccentric crank *A* which is mounted on the main shaft of the press. Adjustment of the pin by means of which connecting-rod *B* is attached to this crank provides for obtaining any desired feeding movement of the stock past the die. At the lower end of the connecting-rod is a vertical rack which meshes with a pinion on one end of a horizontal shaft. A second pinion mounted on the opposite end of this shaft meshes with rack teeth on the under side of pusher-rod *C*. The stock is held in grooves machined in the inside faces of pusher rod *C* and the stationary rod *D*. During each return stroke of the press ram, rod *C* moves toward the right and pushes the stock forward (when the mechanism is arranged for pushing the stock to the die).

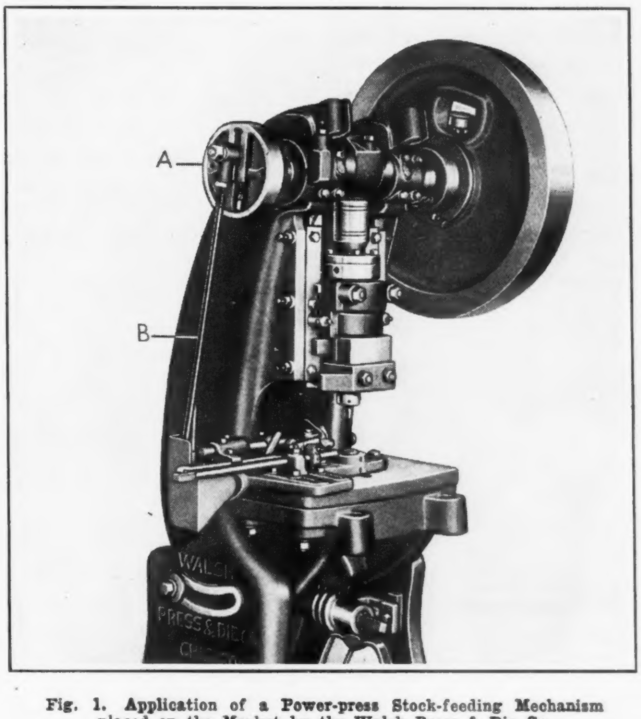


Fig. 1. Application of a Power-press Stock-feeding Mechanism placed on the Market by the Walsh Press & Die Co.

Gripper *E* holds the stock and causes it to move forward with rod *C*. When the stock has been advanced to the required position over the die a trip on the gripper comes into contact with the adjustable dog *G* and releases the hold of the gripper on the stock. Rod *C* then pulls the gripper back, and while this movement takes place an adjustable retaining pawl *I* prevents the stock from moving. When the gripper has returned to the desired point the trip engages a second adjustable dog *J*, which re-engages the stock for the next operation. A handle on the gripper provides for releasing its hold on the stock at intermediate points when necessary.

Ordinarily a V-point is used on the gripper, but a floating flat-ended contact point may be substituted. This will insure that a secure grip is obtained on the stock without marring the surface in any way. From the description

it will be evident that the operation of the device is positive and that by adjusting the positions of the dogs *G* and *J*, the stock may be fed to the die without unnecessary waste of material.

When it is desired to use the mechanism for pulling the stock to the die instead of pushing it, the position of crank *A* is changed 180 degrees on the press shaft. The stock will then be pulled from the right instead of being pushed from the left. Crank *A* is mounted on a plate by means of cap-screws placed in circular slots. This design provides for readily adjusting the movement of the feeding mechanism to the proper relation with the movement of the press ram.

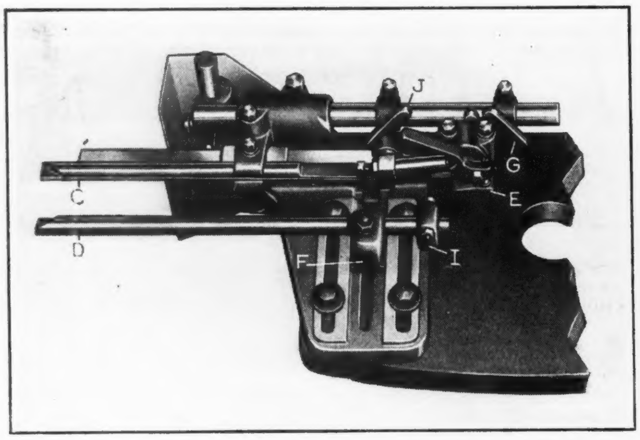


Fig. 2. Close-up View of Walsh Stock-feeding Mechanism for Power Presses

After the device has been attached to a press and the correct relation has been obtained between the feed and the ram movements, the next step is to adjust the mechanism to suit the width of stock to be handled. This is done by shifting the position of bracket *F* which holds rod *D*. The bolt on this bracket serves the double purpose of clamping the bracket to the attachment in the proper transverse position to suit the width of the stock and also of setting the rod in the desired longitudinal position relative to the die. The pinion under the reciprocating rod *C* is next released from the rack teeth of this rod and the rod moved longitudinally to the desired setting, after which the pinion is again placed in mesh with the rack. The mechanism is now set for operation.

HOLLANDER ADJUSTABLE BROACHES

The broaching of square and hexagonal holes, splines, keyways, and round grooves in small lots of work may be accomplished economically by using adjustable broaches made by the Edward Hollander Tool Co., 142 Miller St., Newark, N. J. These broaches are intended to be attached to the spindle of a drilling machine, ram of a shaper or arbor press, toolpost of a lathe carriage, or other machine members suitable for traversing a tool without rotating it. The broaches are made in various styles, the square and hexagonal types being regularly made in all sizes from 1/4 to 3/4 inch across flats. As will be seen in Fig. 1 at *A*, the broach is held in a holder having a micrometer adjustment. Each broach is hollow, the front end being ground to the shape of the hole to be produced and split. The rear end is threaded as shown at *D* and *E* to screw into the holder.

A rod extending through the hollow broach has a pilot screwed on the forward end after the broach has been assembled. This pilot is of the same diameter as the hole to be machined, and thus serves to keep the entire unit steady in an operation. The pilot is provided with ribs which engage the splits of the broach and keep the cutting edges of the tool from swerving sidewise. A detail view of a pilot is illustrated at *C*. The pilot is also employed for adjusting the cutting edges. Prior to the first cut, the ribs of the pilot only slightly engage the splits of the broach. Then, after the broach has been given one pass through the work, the pilot is pulled back to engage the splits a greater amount. In doing this, the taper surface of the pilot causes the cutting edges of the broach to be expanded.

The adjustment of the pilot is accomplished by revolving the knurled member of the holder the desired number of graduations, each of which represents an expansion of 0.001 inch of the cutting edges. By forcing the broach through the work a number of times and making an adjustment after each traverse, the work may be machined satisfactorily to the required dimensions. Each broach is supplied with a gage ring for setting the cutting edges properly to take the first cut. A number of parts finished by broaches of this type are illustrated in Fig. 2.

WARNER & SWASEY STAYBOLT THREADING MACHINE

A machine intended for threading staybolts in railroad shops has been placed on the market by the Warner & Swasey Co., Cleveland, Ohio. This machine is really the No. 4 turret lathe manufactured by this concern provided with a special attachment instead of the regular turret slide and saddle. When not required for staybolt threading, the attachment may be replaced by the regular turret slide and saddle and the machine used for the production of the miscellaneous studs and bolts ordinarily required in railroad shops. The machine is capable of cutting any size of thread on crown, buttonhead, and swivel staybolts up to 40 inches in length. Self-opening die-heads are supplied to meet the requirements of the particular shop in which a machine is installed. In an operation on upset buttonhead forgings which were taper-formed under the head and on which a thread was cut both under the head and on the opposite end, the production rate was one staybolt per minute.

The rough forging is passed through the forward die-head into the square collet of the automatic chuck. The die-head has an enlarged hole in the shank, and the chasers open

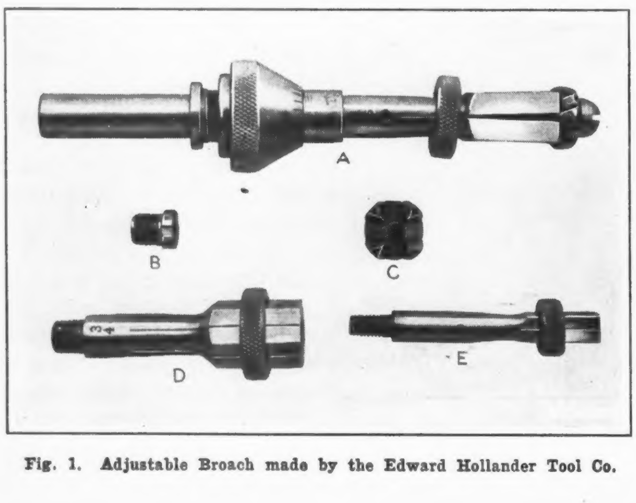


Fig. 1. Adjustable Broach made by the Edward Hollander Tool Co.

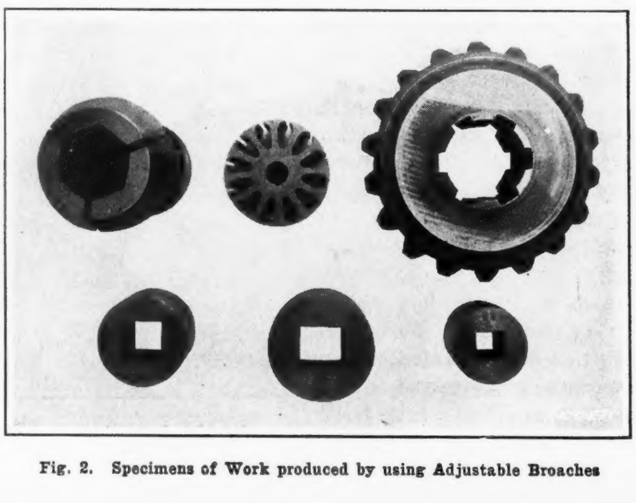
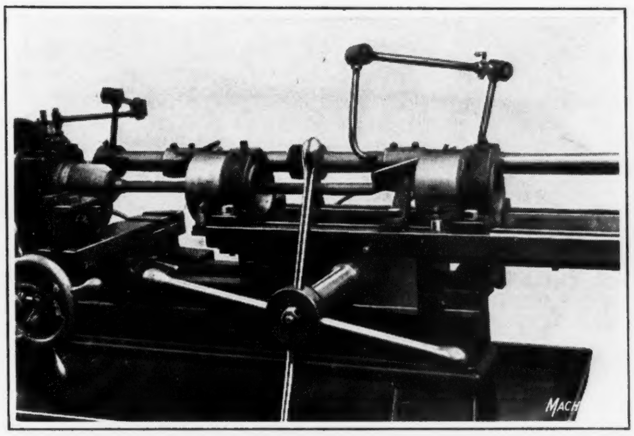


Fig. 2. Specimens of Work produced by using Adjustable Broaches



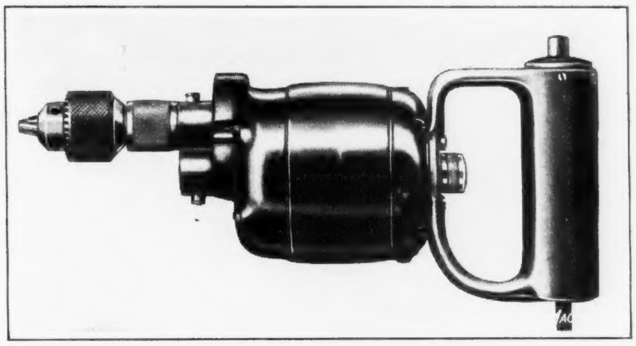
Staybolt Threading Machine built by the Warner & Swasey Co.

exceptionally wide to enable the staybolt to be chucked in this manner. After the work has been chucked, the staybolt carriage is fed forward until the extended end of the bolt is supported in the steadyrest between the two die-heads. The head end is then formed by a cutter on the cross-slide, after which the staybolt carriage is again fed forward during which time the die-heads, being operated by cams at the rear, close automatically and cut the threads.

When the die-heads have passed the cams, the die-heads' again open. The carriage is then returned to the back end of the machine. As the action of the heads is dependent on the contour of the cams, the latter are made to suit the job. The threads on both ends of the staybolt are cut in a continuous lead, the thread on the extended end being cut without any previous machining.

JONES PORTABLE ELECTRIC DRILL

A portable electric drill of 1/4-inch capacity equipped with a high-speed universal motor operating on either direct or alternating current, has been placed on the market by the Consolidated Instrument Co. of America, Inc., 41 E. 42nd St., New York City. The gears are of the helical type, cut



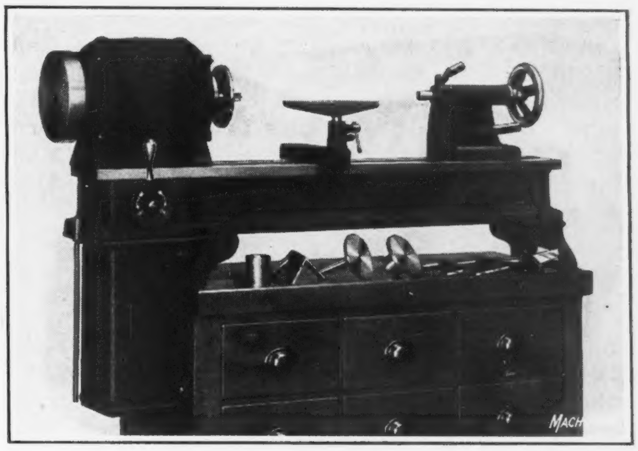
Jones Portable Drill placed on the Market by the Consolidated Instrument Co. of America, Inc.

from tool steel, heat-treated and mounted on shafts ground to size. Ball bearings are provided to take the end thrust of the spindle. The spindle is equipped with a No. 1 Jacobs chuck. The housing is an aluminum casting having a black finish. The over-all length of this tool is 10 inches; the greatest diameter of the motor, 3 inches; and the weight of the equipment, about 4 pounds.

BLOUNT MOTOR-HEADSTOCK PATTERN-MAKER'S LATHE

Patternshop foremen and vocational school instructors will be interested in a bench wood-turning lathe, having a 12-inch swing, which is now being placed on the market by the J. G. Blount Co., Everett, Mass. From the illustration it will be apparent that the driving motor is contained in the headstock. The rotor, outside frame, and necessary windings of the headstock are supplied by the Westinghouse Electric & Mfg. Co. Openings at the bottom of the motor frame provide for connecting leads to the controller directly beneath. The motor end brackets are without openings, and so the unit is fully enclosed. The spindle bearings are mounted in dustproof housings, S K F bearings being furnished. A handle on the front of the bed beneath the headstock is manipulated for starting and stopping the motor. The controller has four running positions giving spindle speeds of 575, 1160, 1750, and 3450 revolutions per minute.

The spindle is made from 0.45 per cent carbon steel, is ground, and has a hole 5/8-inch in diameter bored throughout its entire length. A No. 2 Morse taper hole receives the center. By providing a taper hole of this size, a larger hole may be bored through the spindle than would otherwise be possible. The spindle nose is threaded to receive faceplates,



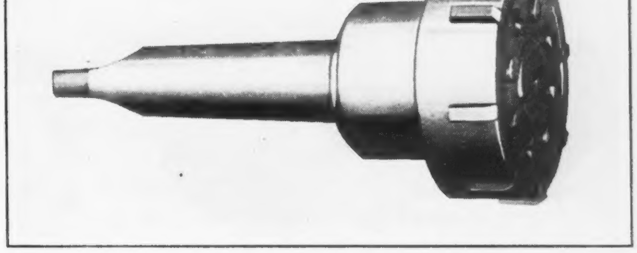
Alternating-current Motor-headstock Wood-turning Lathe made by the J. G. Blount Co.

screw or hollow chucks, and other similar equipment. The bed is made in 4-, 5-, and 6-foot lengths, the maximum distance between centers on the 4-foot bed being 25 inches.

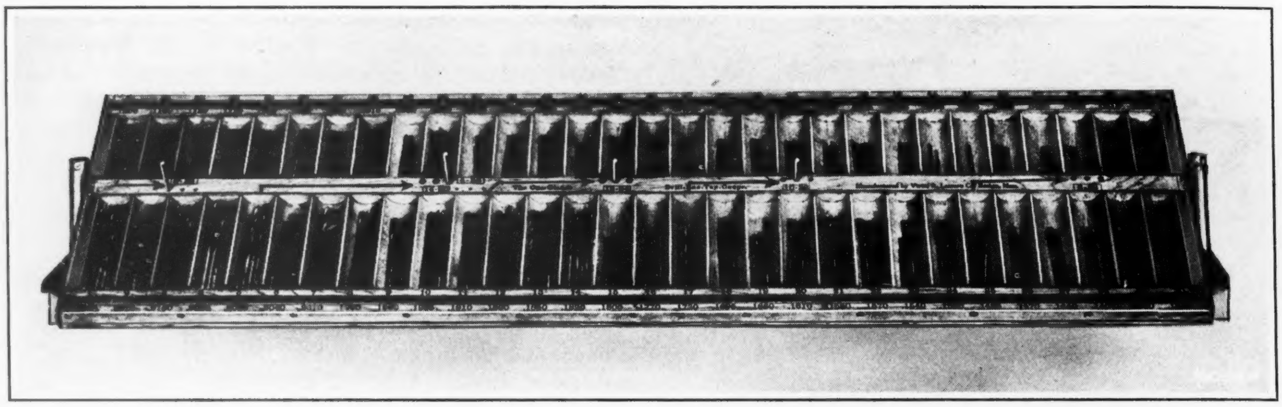
CAMPBELL EXPANDING CYLINDER REAMER

A reamer or boring head intended for refinishing automobile cylinders and having an expansion of approximately 3/8 inch has been brought out by the Campbell Auto Works, 238-240 N. El Dorado St., Stockton, Cal. This head may be screwed on the end of a boring-bar for application on machines of different types. The adjustable members of the reamer are concealed within the head so that dirt or chips cannot interfere with the making of an adjustment. During an adjustment the blades remain in the same relation to one another, and so do not require regrinding to true them up.

An adjustment is quickly and accurately made by first loosening the eight screws on the face of the head which hold a plate securely on the cutters. As the screws are loosened,



Expanding Reamer or Boring Head brought out by the Campbell Auto Works



"One-glance" Drill and Tap Crib made by the Victor R. Lawson Co., which makes it Possible to determine quickly what Drills may be used with a Given Tap

the plate is raised by four coil springs in the body, after which the cutters are free to slide easily in the radial slots in which they are contained. By finally turning the center adjusting screw on the face, the blades are forced outward or inward as desired, and after an adjustment the eight screws are retightened to lock the blades. This reamer is made in different sizes up to 4½ inches in diameter. It has a wide application in turret lathes and similar machines. Application has been made for a patent on this tool.

AMERICAN AMPLIFYING GAGE

An amplifying gage which differs from a larger gage of this type manufactured by the same concern, in that it is limited in range and does not have all the attachments supplied with the larger gage, is now being introduced to the trade by the American Gauge Co., Dayton, Ohio. The new gage is made in two sizes, one of which is intended for work from ¼ to 2 inches in diameter, and the other for work from 2 to 4 inches in diameter. The larger amplifying gage was described in detail in April, 1918, MACHINERY and several of its applications were mentioned in the article entitled "The Delco Inspection System" which appeared in September, 1921, MACHINERY.

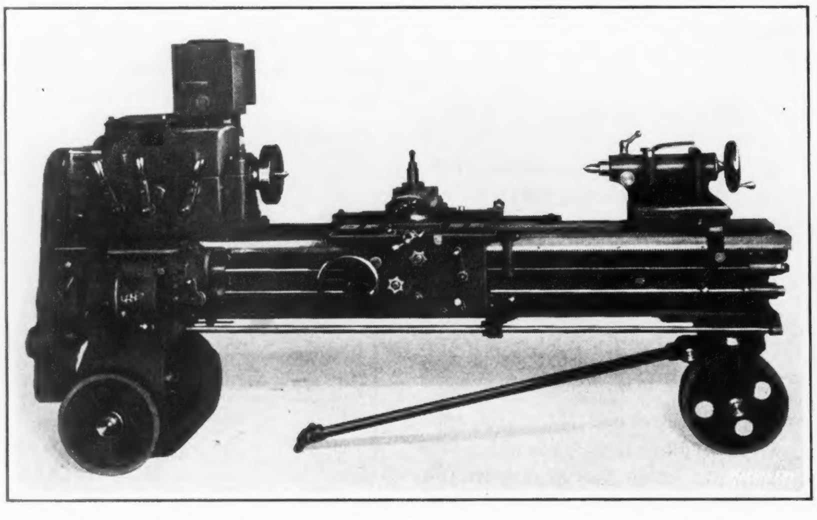
LAWSON DRILL AND TAP CRIB

A drill and tap crib in which gaging holes readily show the proper compartment in which a drill should be placed according to its size has been placed on the market by the Victor R. Lawson Co., 35 Hartford St., Boston, Mass. Another feature of the crib is that the location of the holes for the taps indicate the drills with which a tap of a given size may be used. As will be seen from the illustration, this crib has sixty semicircular drill compartments arranged in two rows. Just above the top row and below the bottom row is a series of gaging holes in a hardened steel strip. Above each of the holes is the number of the drill for which the compartment adjacent to the hole is intended. Beneath the hole is the decimal diameter of the drill. The holes for the taps are located in the maple strip separating the two rows of drill pockets, the taps being held in a perpendicular position. There are three holes for each tap size, each set of holes being arranged adjacent to the correct drills for drilling either a full-, three-quarter-, or half-thread hole. For example, 14-20 taps are in line with the pocket for No. 10 drills. This signifies that a drill of this number is suitable for drilling a hole to have a full thread when tapped by means of a 14-20 tap. The arrow line running from the tap holes to the pocket for No. 5 drills indicates that a drill of that number is the largest that may be used with a tap of this size, a No. 5 drill thus being suitable for drilling a hole in which a half thread is to be tapped.

Each tap hole has sufficient clearance for the tap body except at the bottom where the hole is just small enough to prevent the tap from sliding through. The next smaller size of tap will slide through, and this indicates that it is not the size for which the hole is intended. This crib is mounted on supports which permit it to be tilted to different angles.

LEHMANN PORTABLE GEARED-HEAD LATHE

For use in railroad and other shops handling comparatively large work, where it is often necessary to bring the machine tool to the job, the Lehmann Machine Co., 3560 Chouteau Ave., St. Louis, Mo., has brought out a portable geared-head lathe which, except for the portable feature, is similar to the Lehmann lathe described in January, 1921 MACHINERY. The lathe dealt with in the present article is motor-driven through a belt and pulleys, the speed of the motor being 1800 revolutions per minute. The motor is mounted in the cabinet of the lathe at the head end of the machine. All driving members are covered by suitable guards. The headstock gives sixteen spindle speeds through ten heat-treated gears. The shafts of the headstock run in ball bearings, with the exception of the spindle, which has phosphor-bronze bearings. Two surfaces of different diameters are provided on the spindle nose for faceplates and chucks. Forward or reverse rotation of the spindle is obtained through patented friction clutches which run in oil and are operated by two handles located on the control rod.



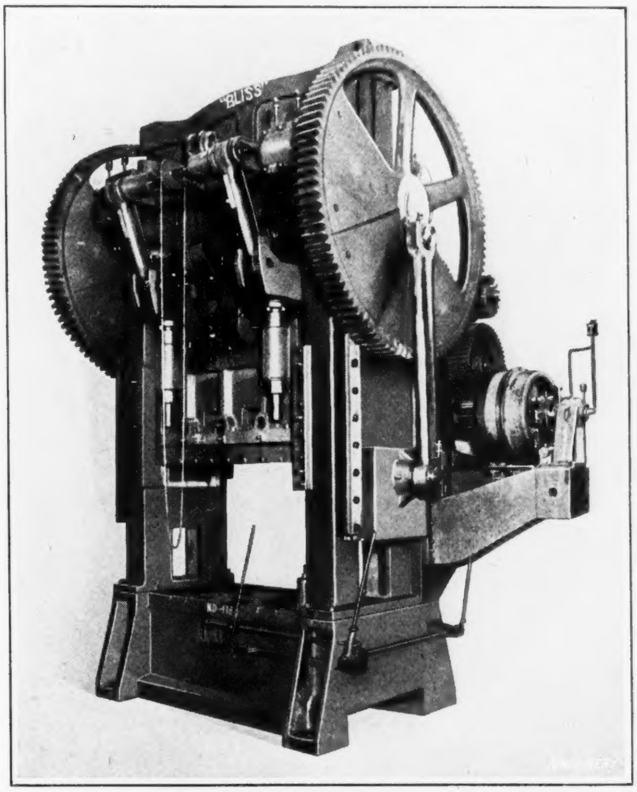
Portable Geared-head Lathe built by the Lehmann Machine Co.

BLISS DOUBLE-CRANK TOGGLE PRESS

During the last few years rapid strides have been made in the development of steel stampings to replace castings, especially in the automobile industry. In order to keep pace with such requirements, it has been necessary to build power presses of sizes and capacity far beyond the dreams of a decade ago. The accompanying illustration shows a press built by the E. W. Bliss Co., Brooklyn, N. Y., for the purpose of drawing pressed-steel axle housings for automobile trucks. These housings are drawn in two sections from steel 3/8-inch thick, which are later welded together. The press is of the tie-rod construction, twin-driven and triple-geared. The ratio of the gearing is 85 to 1. All gears are made of steel, and have machined teeth.

Power is transmitted from the main driving gears to the outside slide or blank-holder through a series of toggles, a dwell of 120 degrees being obtained. In order to keep the construction simple, and at the same time avoid torsional strains, power is transmitted to the blank-holder from both sides of the press. This method is also followed for driving the crankshaft that operates the inner slide, the crankshaft having a driving gear on each end. A 15-horsepower motor mounted on the front of the crown furnishes power for adjusting the inner slide or plunger. The press is driven by a 100-horsepower motor through a hand-actuated friction clutch of the double-grip type.

Some of the principal dimensions of the machine are as follows: Distance from bed to inner slide (stroke down and adjustment up), 59 inches; distance from bed to outer



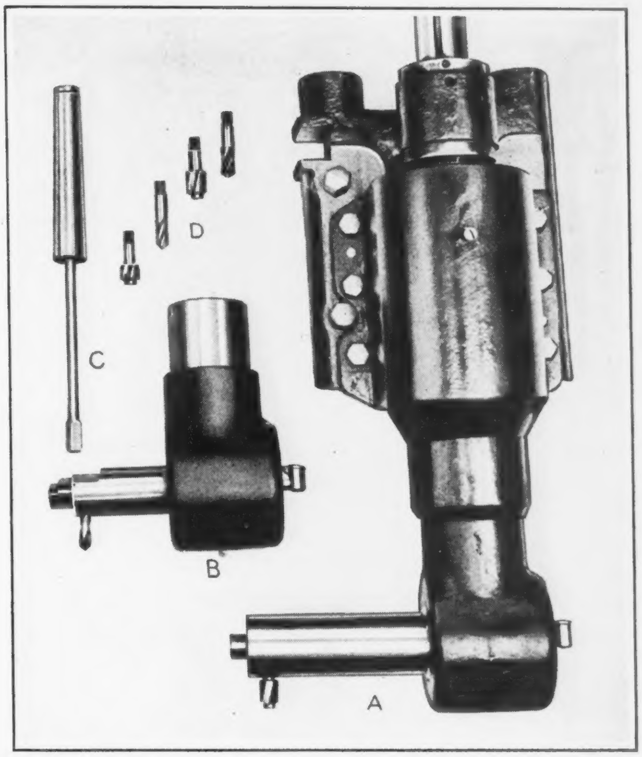
Double-crank Toggle Press built by the E. W. Bliss Co.

slide (stroke down and adjustment up), 56 inches; stroke of inner slide, 28 inches; stroke of outer slide, 20 inches; area of blank-holder face, 5 feet by 8 feet 6 inches; and area of plunger face, 3 feet by 7 feet 3 inches. The weight of this press is about 300 tons.

HARRIS OFFSET DRILLING ATTACHMENT

Port holes and grooves in pneumatic drills, hammers, and riveters can be conveniently drilled, milled, countersunk, and counterbored by the use of an offset drilling attachment brought out by the Harris Engineering Co., Bridgeport, Conn. Another style of offset drilling attachment made by this company for use in standard lines of manufacture was described in September, 1917, MACHINERY. The attachment here dealt with is made to reach into the main bore of the work, and to drill or mill from the inside. It is possible to drill to a specified depth and mill circular, transverse, or longitudinal slots.

Owing to the long overhang under which the tool must work, the offset arm is made as large in diameter as the bore of the air chamber and the depth of the drilling or milling will permit. The entire patented transmission and



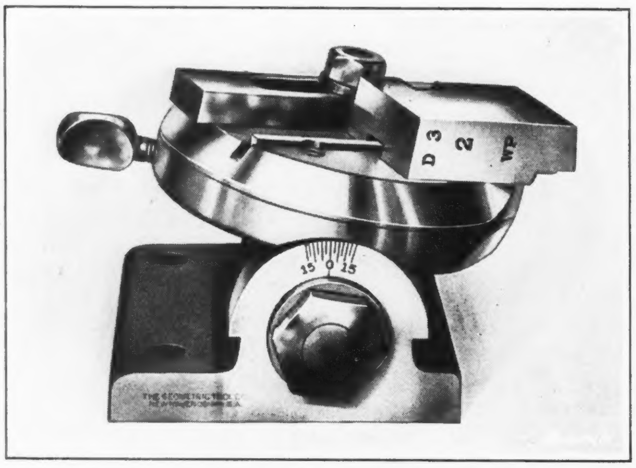
Offset Drilling Attachment made by the Harris Engineering Co.

the offset arm are made from vanadium tool steel and heat-treated. The drills, mills, and counterbores are ground and lapped to fit the spindle in the outer end of the arm. They can be quickly interchanged, and have a limited adjustment for depth which allows for grinding, setting, etc.

An attachment mounted in a special bracket provided on a vertical milling machine is shown at *A* in the accompanying illustration. To the left of this at *B* is an attachment having a shorter arm which is interchangeable in the special bracket. Spindle *C* has a taper shank that is inserted in the regular machine spindle, while the lower end is squared to fit a hole in the attachment and thus transmit power to it. Several tools for the attachment are shown at *D*. This equipment may also be used for the inside drilling or milling of oil-grooves, straight or spiral holes for holding babbitt in bearing boxes, blind keyways to retain a feather or key, etc.

GEOMETRIC CHAMFER GRINDING FIXTURE

One of the essential points in thread chaser grinding is that the chamfer be ground an equal amount on all chasers of a set. When the chamfer is ground unevenly, the burden of cutting comes on one or two of the chasers with the result that threads are cut out of lead, tapered, or with other irregularities. In order to grind thread chasers satisfactorily, the Geometric Tool Co., New Haven, Conn., has brought out the fixture here illustrated. This fixture is intended principally for grinding chamfers on the Geometric milled form of chasers, but it may also be used for grinding chasers of the tapped form. With chasers of the latter form, how-



Thread-chaser Grinding Fixture brought out by the Geometric Tool Co.

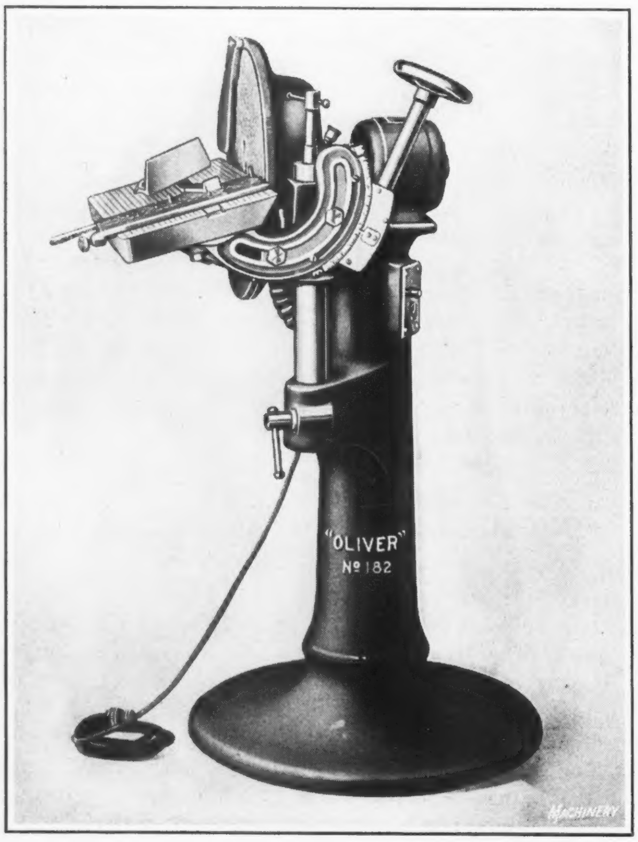
ever, the grinding is straight and does not conform to the contour of the chaser threads.

The table of the fixture is graduated and may be set for grinding long or short chamfers. The narrow key engages the keyway of the chaser and acts as a guide while grinding. An adjustable stop governs the position of the chaser with respect to the grinding wheel. The side of the fixture is also graduated to enable the table to be tilted accurately to the desired angle of chamfer clearance. One fixture accommodates all sizes of chasers, and left- as well as right-hand chasers can be ground. When used for 5/16-inch chasers, it is necessary to remove the key, and guide the chaser in the keyway.

When the fixture is bolted to the table of a grinding machine, the chaser must be slid forward by hand to the wheel and against the stop provided on the fixture. However, on machines that permit of so doing, the chaser may be fed forward by means of the machine handwheel or lever to a stop arranged on the machine. The fixture may also be mounted on a machine slide, and the chaser ground by passing it back and forth across the edge of the grinding wheel.

OLIVER MOTOR-DRIVEN DISK SANDER

Patternmakers will be interested in a motor-driven disk sander now being placed on the market by the Oliver Machinery Co., Grand Rapids, Mich. This machine is particularly adapted for accurately sanding segments, angular sections, core-prints, and circular and taper work. It can also be used in machine shops for medium and light metal work.



No. 182 Motor-driven Disk Sander placed on the Market by the Oliver Machinery Co.

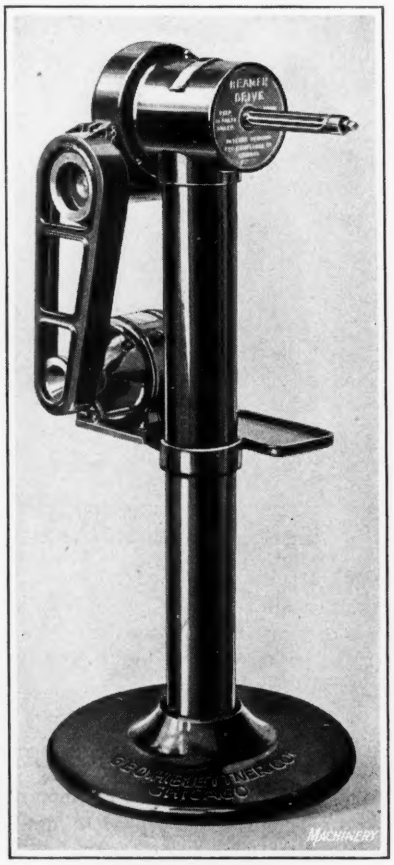
The steel disk plate which is 15 inches in diameter, is removable for renewing the sandpaper or emery cloth on its front face. The disk travels at a speed of 1725 revolutions per minute.

The table has a groove to receive angle, and circle, segment and duplicating gages. It tilts 45 degrees downward from the horizontal plane and 25 degrees upward, a graduated index showing the angle at which it is positioned. A vertical adjustment of six inches provides for handling a variety of work. The angle gage is graduated from 0 to 45 degrees both to the right and left to enable accurate settings. Either an alternating- or direct-current motor is provided, the motor being coupled to the disk shaft in such a manner that it does not receive thrusts from the latter. The controlling switch is of the push-button type, and is located on the column. This machine is portable and is intended to receive electric current from a lighting circuit.

BLETTNER REAMER DRIVING MACHINE

Reaming finished holes to size in the assembly of machines or mechanical units is facilitated by a machine produced by the George H. Blettner Co., 1841 W. Jackson Blvd., Chicago, Ill., which is shown in the accompanying illustration. This machine drives hand and machine reamers of various styles up to 1½ inches in diameter. The driving mechanism is located at the top of the pedestal, and driven from a 1/6-horsepower alternating- or direct-current motor through a round belt. A three-step pulley provides three spindle speeds of 10, 20, and 30 revolutions per minute, respectively. The operator stands directly in front of the machine, and, while holding the work in his hands, feeds it on the slowly revolving reamer which centralizes itself.

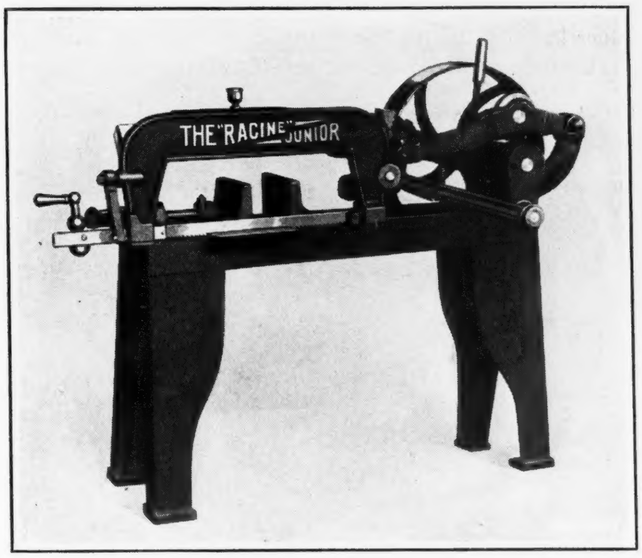
The spindle is fitted with a 5-inch Cushman geared scroll chuck. All end thrust in the machine is taken up by ball bearings, and the gear-case is oil-tight so as to retain the lubricant. The electric current switch is of the self-contained tumbler type. It is said that by using this equipment holes will be given a better finish than when sizing by hand, and the work can be done more quickly. The distance from the floor to the center of the spindle is 38 inches, and the weight of the machine is approximately 145 pounds.



Reamer Driving Machine made by the George H. Blettner Co.

RACINE HIGH-SPEED HACKSAW MACHINE

Light-gage or hand hacksaw blades may be used advantageously on the "Junior" medium-duty hacksaw machine built by the Racine Tool & Machine Co., Racine, Wis., because of the positive mechanical lift on the non-cutting stroke of the blade. The machine operates on the draw-cut principle, gravity alone being relied upon for feeding the blade an amount suitable for the different grades of metal being cut. An automatic knock-out stops the saw when a piece has been cut through. The saw-frame guide is held automatically at any height, which is a convenience when placing stock in the vise. Adjustment for wear is provided on the saw frame guide which slides on V-ways. The normal capacity of this machine is for stock 4 by 4 inches, but by a simple adjustment the capacity may be increased to 6 by 6 inches. The stroke range of the machine is from 60 to 100 per minute, and the stroke is 6 inches in length. The weight of the equipment is 150 pounds.



Racine "Junior" Metal-cutting Machine built by the Racine Tool & Machine Co.

DAVIS-BOURNONVILLE TUBE-BENDING MACHINE

The bending of No. 22 gage 7/16-inch diameter tubing to the shape of a tennis racket frame is accomplished by means of a machine built by the Davis-Bournonville Co., Jersey City, N. J. A general view of this machine is shown in Fig. 1. Two separate operations are required to complete the bending, the machine being first set up for giving a preliminary bend to a quantity of work, and then arranged for giving these parts a subsequent bend. The preliminary shape is obtained by bending the tube around a form on the table by means of two arms or cranks keyed to vertical oscillating shafts. These members are clearly shown in Fig. 2. The cranks are driven through worm-gearing and a crank motion beneath the table, a clutch being provided for starting and stopping their operation. The rollers on the end of the cranks engage the tube and bend it around the large form. The normal cycle of steps in this operation is to bend and release the part and stop the machine, the operator then removing the part and replacing it with another straight tube.

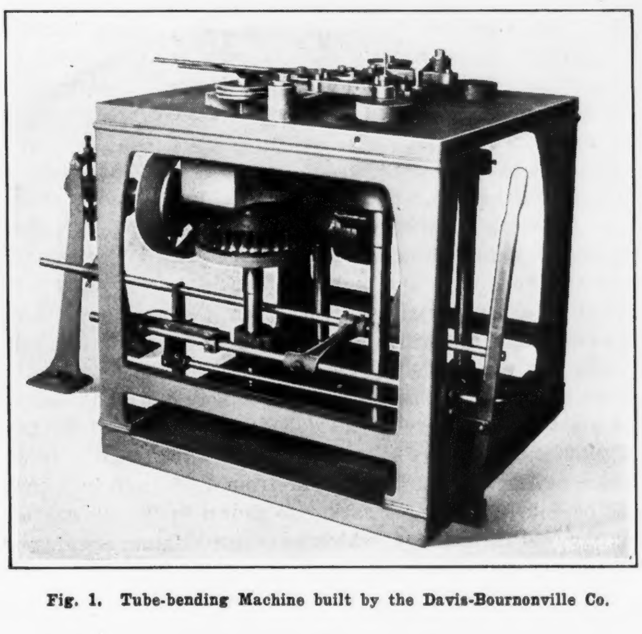


Fig. 1. Tube-bending Machine built by the Davis-Bournonville Co.

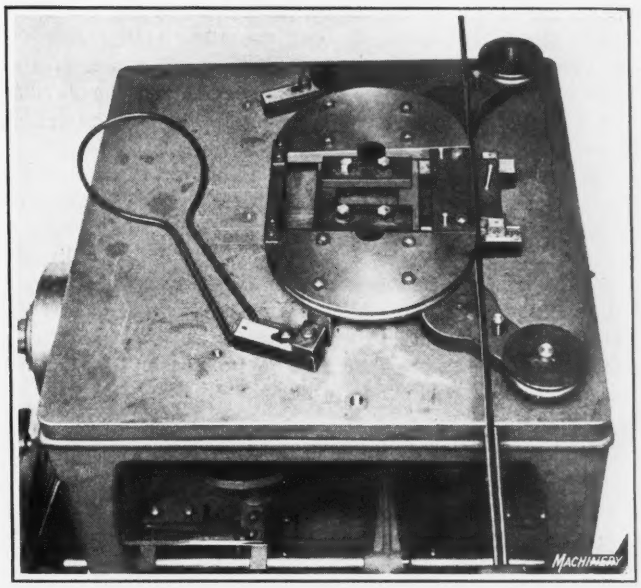


Fig. 2. Tool Set-up for the Preliminary Bending Operation

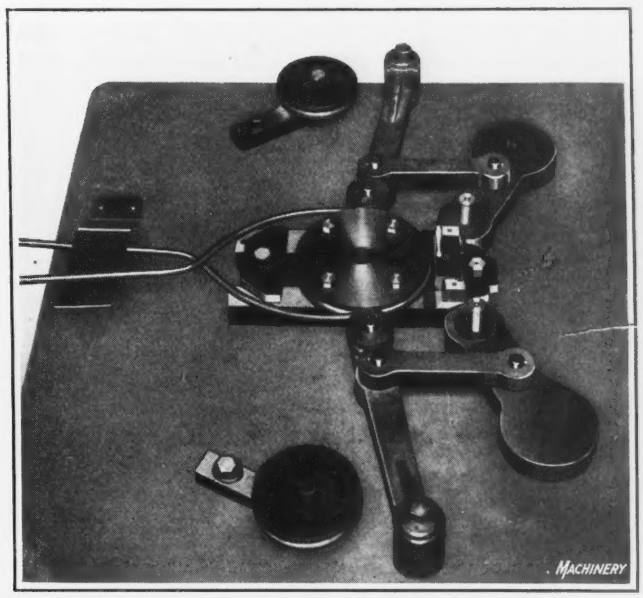


Fig. 3. Final Operation in bending Tubing

After a quantity of frames has been run through the first operation, the bending tools are changed for those shown in Fig. 3. It will be noted that the rollers on the crank ends have been removed and are employed as stops. They are so positioned that the partly bent frame, when placed on the machine for this operation, will be located by the rollers midway on the form at the center. Links which are connected to studs midway on the crank arms are attached at their opposite ends to another pair of swinging arms having small rollers which engage the tube. In the second operation the frame is closed by the rollers on the swinging arms as the

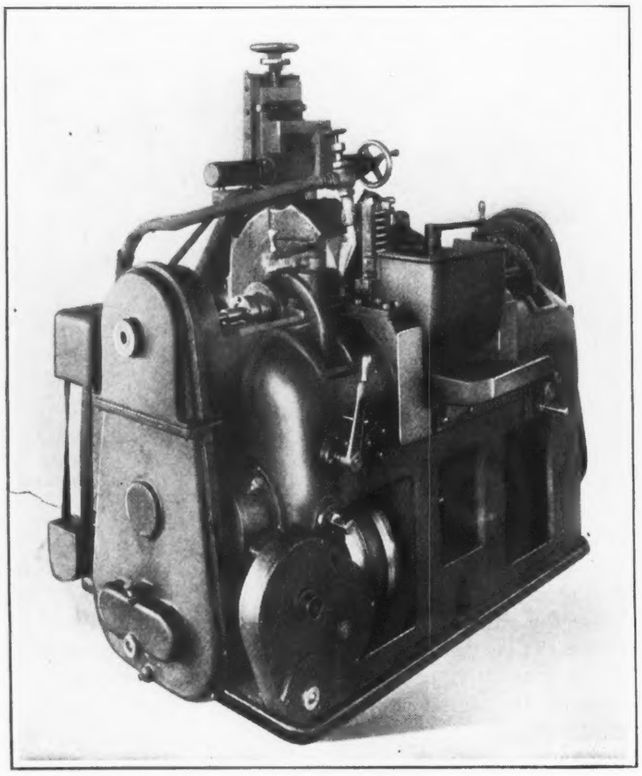
cranks are operated, one leg of the frame passing under the clip at the left of the table, and the other riding over the top. It is necessary to bend the frame through a greater angle of curvature than is actually desired on the finished part, in order to overcome the spring and allow the tubing to set.

The machine normally operates at an average rate of 600 bends per hour, the speed of the driving shaft being 300 revolutions per minute. On normal production, the machine is started and stopped for each bend, but when facility in handling the work has been acquired and maximum production is essential, the clutch latch may be thrown out and the machine then operated without stopping to insert the tubes and remove the bent shapes. The production is thus increased to about 1000 bends per hour.

FRASER AUTOMATIC CYLINDRICAL GRINDING MACHINE

Shackle and king bolts, valve tappets, piston-pins and other parts having cylindrical surfaces to be ground may be handled rapidly in large quantities on the automatic grinding machine here illustrated. This machine has been patented and is now being built by the Warren F. Fraser Co., Westboro, Mass. The work is held either between centers or in a draw-in chuck. The wheel-head is heavy, and the spindle of generous proportions to enable it to carry grinding wheels 18 inches in diameter and up to 6 inches in face width. Force-feed lubrication is furnished for all bearings, and all controls can be easily and quickly reached. The machine is self-contained, being driven by a 15-horsepower motor through a 4½-inch belt. However, the machine may also be driven from an overhead countershaft or jack-shaft through a constant-speed belt.

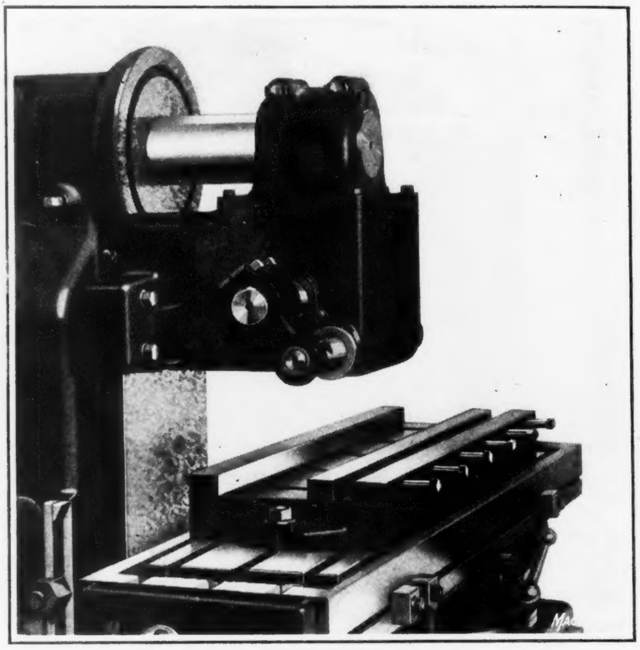
The time required for setting up this machine for a job is no greater than for rigging up an automatic screw machine, and in grinding piston-pins ⅞ inch in diameter and 3¼ inches in length, an average production of five pins per minute was attained. One operator can run as many as four machines. This machine will grind pieces from ½ inch in diameter upward, and up to 6 inches in length, the maximum distance between centers being 10 inches. The machine weighs approximately 7000 pounds. This company also has a small machine in the process of development which will weigh about 4000 pounds and will grind surfaces from ⅛ to 1½ inches in diameter and up to 2 inches in length. The maximum length of work which can be placed between the centers of this machine will be 8 inches.



Automatic Cylindrical Grinding Machine brought out by the Warren F. Fraser Co.

ROCKFORD RACK CUTTING AND INDEXING ATTACHMENTS

Rack cutting and indexing attachments designed especially for application to the heavy-duty and No. 1½ milling machines built by the Rockford Milling Machine Co., Rockford, Ill., have been placed on the market by the same concern.



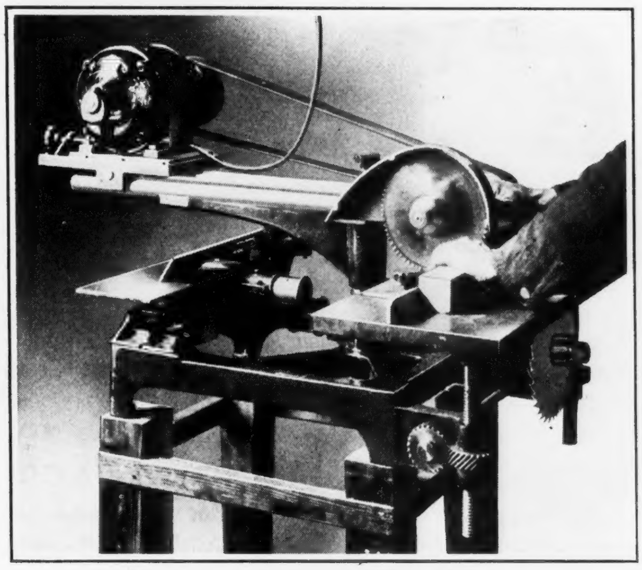
Rack Cutting Attachment and Special Vise added to the Equipment made by the Rockford Milling Machine Co.

The rack cutting attachment is securely clamped to the face of the column and is further supported by the overhanging arm at a point directly above the attachment spindle, where there is the greatest strain. The attachment is driven through a shank held in the machine spindle by means of the tang and a drawback. A hardened spur gear keyed and pinned to the shank drives a second gear keyed to a double-lead worm. The latter engages a worm-wheel which has two spur gears keyed to it, one on each side. These transmit power to the attachment spindle through gears cut solid on this member. The attachment spindle is made of alloy steel, and runs in bronze taper bearings that have means of adjusting for wear.

The rack indexing attachment (which is not illustrated) is fastened to the left-hand end of the table by means of the central T-slot. It consists of a bracket carrying an indexing and locking disk and change-gears. This device permits of cutting rack teeth and making other settings without relying on the usual dial. Various gear combinations enable racks of different pitches to be indexed by making one-half, one, or two turns of the locking disk. The cutting of racks to the following diametral pitches is possible by means of the eighteen change-gears furnished: 3 to 6 by half pitches, all pitches from 7 to 16, and all even pitches from 18 to 32. Racks having circular pitches of from 1/16 to 1 inch may also be cut. The special rack vise shown in the illustration has jaws 30 inches long, which have a maximum opening of 5⅝ inches.

HUTCHINSON COMBINATION WOOD-WORKING MACHINE

Fifteen different operations may be performed on a small combination woodworking machine brought out primarily for pattern shop use by the Hutchinson Mfg. Co., Inc., Norristown, Pa. This machine can be employed as a swing saw, for cross-cutting square ends of long stock, for mitering and for dadoing. In performing such work, the operator can always clearly observe the cuts being taken. The machine is especially suitable for routing out core-boxes, cutting all kinds of segments, jointing, and planing. The table moves up and down while the machine is in operation and may also be swiveled. Another advantage of this design is that two men can work on opposite sides at the same time.

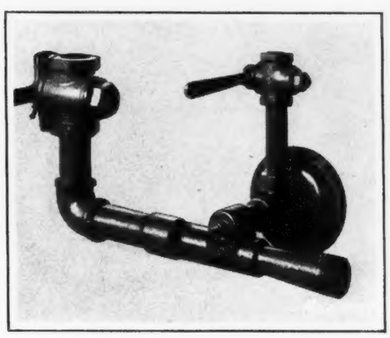


Small Combination Woodworking Machine brought out by the Hutchinson Mfg. Co., Inc.

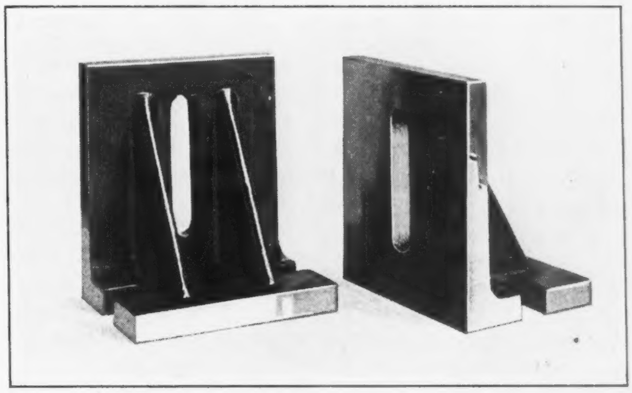
The machine may be mounted on a small stand having rollers which will enable it to be readily moved about the shop. It is driven by a ½-horsepower motor, and weighs 245 pounds.

SURFACE COMBUSTION AIR-GAS INSPIRATOR

The low-pressure air-gas inspirator supplied in past years on furnaces built by the Surface Combustion Co., 362 Gerard Ave., Bronx, New York City, has been redesigned so as to be applicable to other makes of gas furnaces. The entire operation of a furnace equipped with this device is controlled through one valve. An increase or decrease in the air supply automatically causes the amount of gas delivered to be also increased or decreased, so that the mixture proportions remain in a constant ratio. The gas cock is operated only when starting or stopping the heating of a furnace, and is either altogether on or off, no intermediate positions being required. It is said that no explosive mixtures are possible in any part of the distribution mains, as the gas and air are mixed only at the point of supply to the burners. The advantages claimed are an automatic supply of air and gas in the desired proportions under all conditions, thorough mixing of the air and gas just prior to entering the furnace, and an instantaneous combustion.



Air-gas Inspirator made by the Surface Combustion Co.



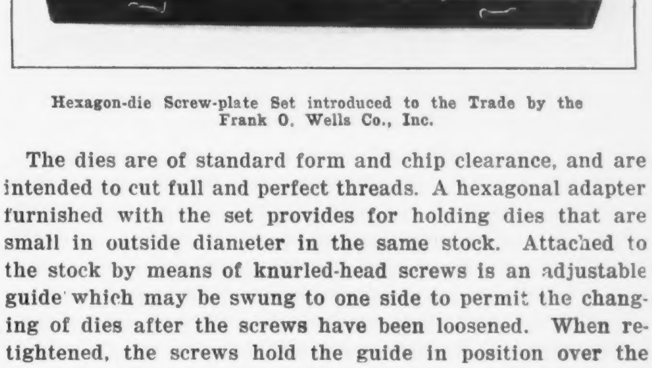
Precision Angle-irons made by the Simplex Tool Co.

SIMPLEX PRECISION ANGLE-IRONS

Two of a set of precision angle-irons made in three sizes, to provide for a variety of combinations suitable for the general run of machine shop work are shown in the accompanying illustration. These irons are manufactured by the Simplex Tool Co., Woonsocket, R. I. They are made of a high grade of cast iron, and the clamping surfaces are accurately finished. Slots provide a means of holding the irons to surfaces of machine and other parts. The sizes in which the angle-irons are made are 4 by 5 by 5 inches; 6 by 6 by 8 inches; and 8 by 10 by 12 inches.

WELLS SCREW-PLATE SET

A screw-plate set having several new features has just been brought out by the Frank O. Wells Co., Inc., 305 Wells St., Greenfield, Mass. It will be seen from the illustration that the dies of this set are hexagonal. The die-stock is made of an aluminum alloy, and the tap wrench is made of steel and has hollow handles to reduce its weight. The dies are made adjustable by splitting one side and providing a fillister-head screw for drawing the split ends together. By holding these ends in this manner the dies may be turned with an ordinary socket wrench instead of using the stock. This is convenient when working under cramped conditions.



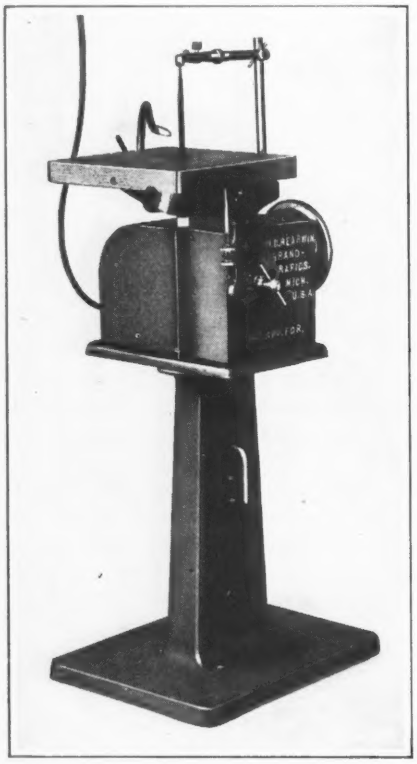
Hexagon-die Screw-plate Set introduced to the Trade by the Frank O. Wells Co., Inc.

The dies are of standard form and chip clearance, and are intended to cut full and perfect threads. A hexagonal adapter furnished with the set provides for holding dies that are small in outside diameter in the same stock. Attached to the stock by means of knurled-head screws is an adjustable guide which may be swung to one side to permit the changing of dies after the screws have been loosened. When retightened, the screws hold the guide in position over the center of the die and lock the jaws of the guide so that they will not move while threading a number of pieces of one size. The cutting faces of the dies are formed by broaching, the correct shape being produced and an equal distance maintained between all cutting lands in this way. The set is made with both U. S. standard and S. A. E. forms of thread.

REARWIN DIE-FILING MACHINE

A No. 4 small-size die-filing machine which may be mounted on a bench or on a pedestal having elevating rollers has been added to the line of die-filing equipment manufactured by W. D. Rearwin, 716 Monroe Ave., Grand Rapids, Mich. When the rollers are lowered and the pedestal raised the machine can be conveniently moved about the shop. After it is taken to a desired location, the base of the pedestal furnishes a solid foundation when the rollers are again raised. Power for driving the machine may be obtained from any electric light socket. A 1/6-horsepower motor running at 1720 revolutions per minute is provided, which is fully enclosed in a sheet-metal case to protect it from filings and dirt.

The file is reciprocated by a ram driven through a crank and connecting-rod. By adjusting the throw of the crank it is possible to obtain any length of stroke up to 3 inches. The effective length of the connecting-rod can also be adjusted to bring the working section of the file into any desired position relative to the work. Three changes of speed are obtained through a cone pulley, namely 200, 300, and 400 strokes per minute.

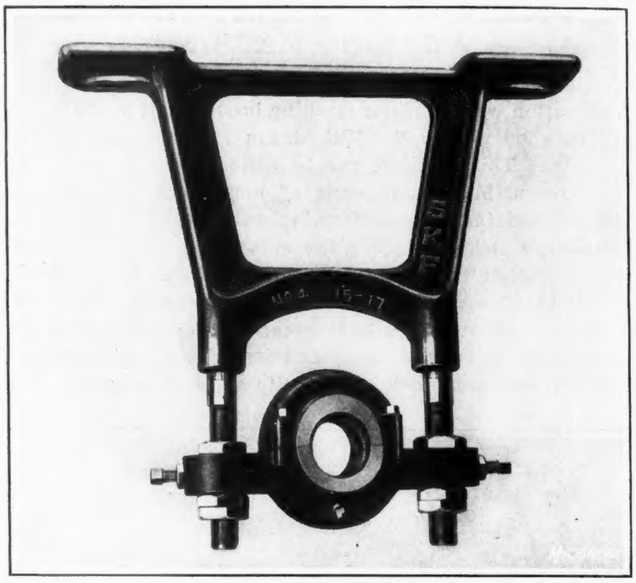


Die-filing Machine built by W. D. Rearwin

To enable various degrees of clearance to be filed in dies, the work-table is pivoted on a yoke, and this, in turn, is pivoted on the frame of the machine. Each of these pivotal supports has a graduated dial which facilitates rapid and accurate setting of the table to the desired clearance angles. There is an outboard support for the file, and files of standard or special types can be used. The table is at a convenient height for a man sitting on a stool. The table is 12 inches square, and the entire machine weighs about 80 pounds. A smaller size machine built along the same lines and known as the No. 3 is made with a table 8 inches square and a file stroke of 1½ inches.

SKAYEF BALL-BEARING HANGER

An improved ball-bearing hanger with a two-point suspension for the bearing box is now being manufactured under the supervision of the S K F Industries, Inc., 165 Broadway, New York City. The self-aligning ball bearing incorporated in the old type hanger is also included in the new. The bearing is contained in a split housing rigidly held by two suspension rods. This arrangement gives a compact unit, easily assembled, located, or inspected. Vertical or horizontal adjustments can be readily made at the end of the housing by means of lock-nuts and set-screws. This obviates the possibility of applying pressure to the bearing while making adjustments.

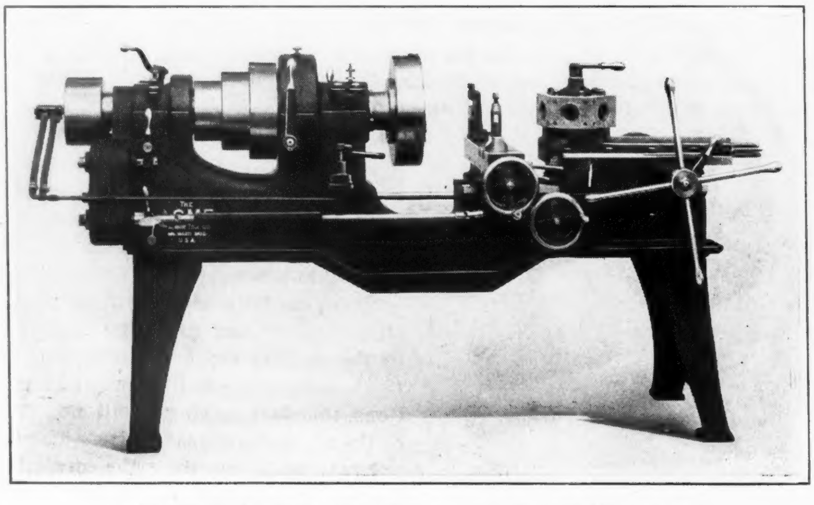


Skayef Ball-bearing Hanger

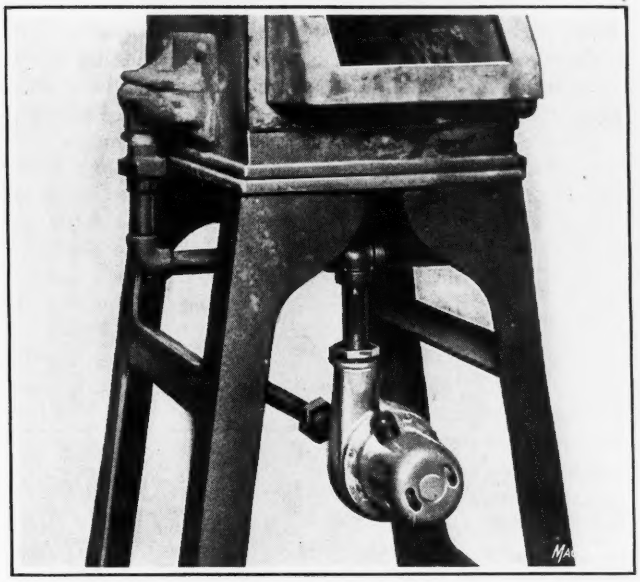
The self-aligning feature of the bearing allows the shaft to turn freely at all times with a minimum amount of friction and subsequent heating. Millwrights will appreciate the fact that when using these hangers for an installation the shaft may be laid out on the floor with the bearings in plain view and then raised into position for final adjustment with the upper half of the housings off.

CINCINNATI ACME GAP TURRET LATHE

A departure from the standard design of turret lathes has been made by the Acme Machine Tool Co., Cincinnati, Ohio, in bringing out the gap turret lathe here illustrated. This machine was designed particularly for the handling of chucked work that is large in swing relative to its length. Many castings and forgings which ordinarily cannot be machined on a turret lathe of corresponding nominal size can thus be accommodated because of the gap. The machine is made to the dimensions of the regular 20-inch Cincinnati-Acme turret lathe built by the same concern, except that the gap provides for a maximum swing of 28 inches. The length of the gap from the front end of the spindle is 9⅛ inches. The machine is equipped with an air chuck, and has a power feed for the cross-slide and a longitudinal power feed for the turret. The minimum distance from the end of the spindle to the turret face is 14¾ inches; the minimum distance from the end of the spindle to the inside edge of the cross-slide, 8⅛ inches; the transverse movement of the cross-slide, 7 inches, and the lateral movement, 4 inches.



New Design of Turret Lathe built by the Acme Machine Tool Co.



Gas Furnace equipped with Electric Blast made by the Clements Mfg. Co.

CADILLAC ELECTRIC GAS-FURNACE BLAST

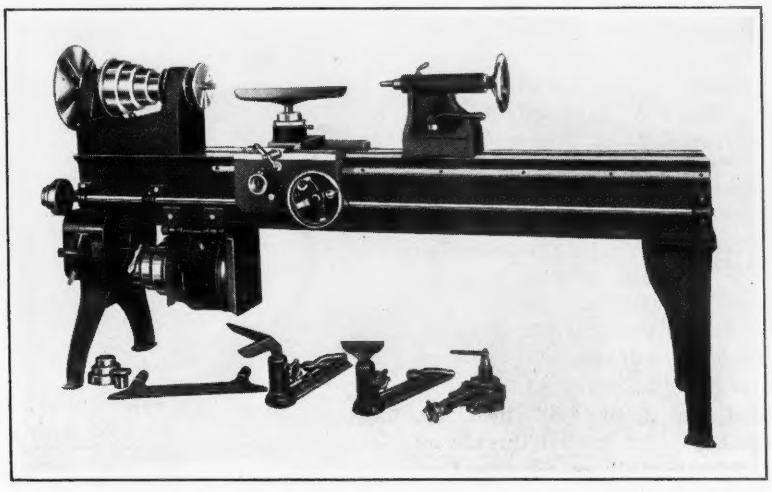
An electrically operated blast intended for application to gas furnaces for regulating the mixture of air and gas delivered to the furnace is now being placed on the market under the trade name of "Cadillac" by the Clements Mfg. Co., 606 Fulton St., Chicago, Ill. This blast is driven by a 1/6-horsepower universal motor and delivers 210 cubic feet of air per minute at a motor speed of 10,000 revolutions per minute. Current for driving the motor is taken from a lighting socket; this offers a convenient means of heating a furnace after regular working hours.

The functioning of the device is similar to that of an automobile carburetor. The mixture of air and gas should be rich until the furnace has been warmed up, after which a damper on the blast adjacent to the blower should be gradually opened to admit more air. This blast is not dependent upon a normal gas pressure, a sufficient amount of gas being drawn from the mains to heat a furnace without variation.

IMPERIAL PATTERNMAKER'S LATHE

A motor-driven patternmaker's lathe built in sizes of 16-, 20- or 24-inch swing and with standard bed lengths of 8 and 10 feet, is a recent product of the Imperial Metal Products Co., Ionia and Newberry Sts., Grand Rapids, Mich. This lathe has a headstock which can be swung about five degrees each side of the center to provide for turning tapers. The spindle is threaded on both ends for the accommodation of faceplates. Double-row self-aligning S K F ball bearings take the end thrust of the spindle as well as radial loads. The tailstock is of the open-side type and may also be set over for turning tapers. The compound rest is graduated to enable quick settings to be made at various angles.

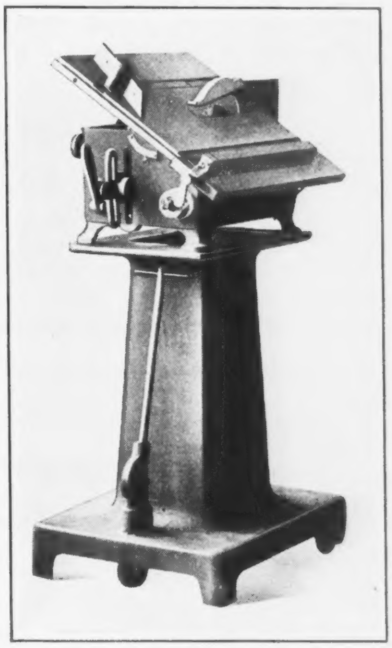
The carriage is regularly furnished with a power feed, but a hand-fed carriage can also be supplied. On the power-fed machine, the feed can be started or stopped by turning a friction knob on the apron, or reversed by the manipulation of a lever. The two-horsepower motor with which the machine is equipped is mounted on an adjustable base which allows for tightening the driving belt. Belt shifters and a controlling box are conveniently located. A brake lever operating on the inside of the spindle cone pulley enables the rotation of the spindle to be stopped instantly. The machine may also be equipped for driving from a countershaft.



Porter Patternmaker's Lathe manufactured by the Imperial Metal Products Co.

UNION PORTABLE SAW BENCH

A universal saw bench mounted on a pedestal having rollers and a handle which facilitate its transportation about the pattern shop is now being introduced to the trade by the Union Machine Co., 30 Ottawa Ave., N. W., Grand Rapids, Mich. The saw is driven by a ½-horsepower motor, and will cut stock up to 2 inches thick. The table can be tilted to any angle up to 45 degrees and locked in place, a graduated dial and pointer indicating its position.



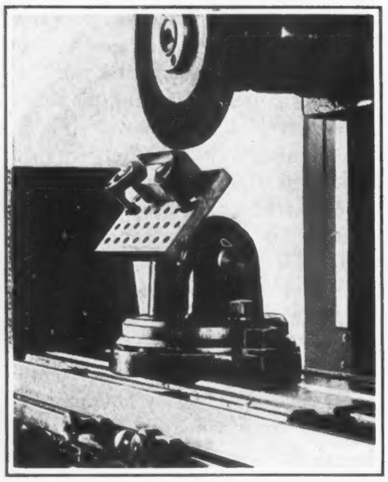
Portable Saw Bench made by the Union Machine Co.

The cross-cut gage may be used on either side of the saw, and can be quickly set to any angle and clamped in position. The ripping gage may also be used on either side of the saw. This gage is automatically lined up with the saw when locked in position. The saw is seven inches in diameter, and may be either of the ripping or cross-cut type, or a combination of the two suitable for both classes of work. A splitter guard keeps the stock from pinching the saw. The saw arbor yoke is hinged so that it can be raised and lowered to adjust the height of the saw above the table surface.

Two rollers at the back of the pedestal and two stationary feet at the front furnish a firm support on the floor when the machine is in operation. Pulling the handle forward raises the feet and brings the weight of the front of the machine on a third roller carried on a swivel bearing that moves with the handle.

KRAG UNIVERSAL ANGLE FIXTURE

Tool-room jobs in which it is necessary to hold the work in angular positions while being machined may be performed readily by using the "Little Bob" universal angle fixture made by E. L. Krag & Co., 50 W. Randolph St., Chicago, Ill. This device has a work-holding plate which may be swiveled 90 degrees on either side of a horizontal



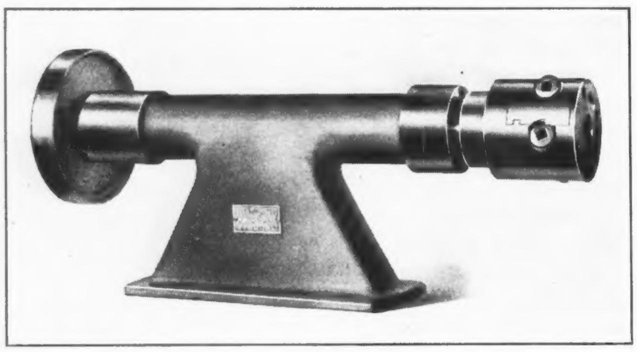
Universal Angle Fixture made by E. L. Krag & Co.

plane and which may also be revolved around an entire circle. Graduated dials facilitate the settings. All surfaces of the plate are ground square with each other, and this member has a series of holes which provide for the quick clamping of work by means of patented clamps.

The plate is hinged on a $\frac{3}{4}$-inch stud, threaded on one end, which is used to clamp the plate in desired positions relative to the horizontal plane. Large flanges on the plate engage the faces of bosses on the yoke lugs and produce a sufficient friction to hold the plate fast under all conditions. The yoke casting revolves on a $1\frac{1}{2}$-inch pilot at the center of the base, the yoke being secured by two $\frac{1}{2}$-inch bolts which ride in a circular T-slot machined in the base. The size of the fixture plate holding surface is $3\frac{3}{8}$ by $4\frac{3}{4}$ inches, and the weight of the entire fixture, 25 pounds.

MARVIN & CASLER LAPPING AND FILING LATHE

To provide for lapping and filing small work without tying up a lathe or other more expensive equipment, the Marvin & Casler Co., Canastota, N. Y., has brought out the lapping and filing head or "lathe" shown in the accompanying illustration. This head consists essentially of a casting which



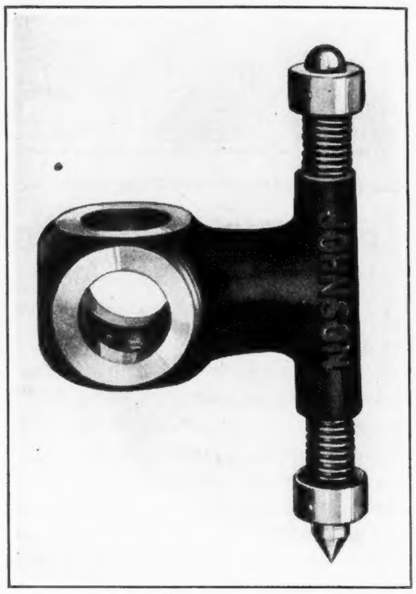
Lapping and Filing Head made by the Marvin & Casler Co.

supports a spindle running in ball bearings. The spindle is driven by a pulley mounted on one end, while at the other end is attached either a Casler twin-screw drill chuck or a three-jaw chuck. The twin-screw chuck was described in April, 1919, MACHINERY. The casting is designed to permit the ready attachment of a guard for the driving belt. The base of the casting is $10\frac{3}{4}$ inches long and the distance from the pulley to the drill chuck is $14\frac{3}{8}$ inches.

JOHNSON CENTER-LOCATING PUNCH

Toolmakers and diemakers will appreciate a means for quickly and accurately locating centers of holes on such work as jigs, dies, etc., without relying on the button method. The combination prick-punch and scriber here illustrated has been designed for this purpose, and is manufactured by Bernard F. Johnson, 3476 Boulevard, Jersey City, N. J. One method of using this device is to mount it on the cutter-arbor of a milling machine, with the punch perpendicular, and with the part to be laid out attached to the machine table. Then the centers of holes to be bored later may be located by shifting the work beneath the punch, using the adjusting screws of the table and saddle. By reference to the dials of these screws, centers for holes may be located within the limits of the accuracy of the machine. After each adjustment, a prick mark is made by tapping with a hammer on the upper round head of the punch. Then, when all centers have been located, the work may be mounted on the faceplate of a lathe and drilled and bored in the customary manner after centering by means of an indicator. It will be apparent that the coil springs normally hold the punch from the surface of the work.

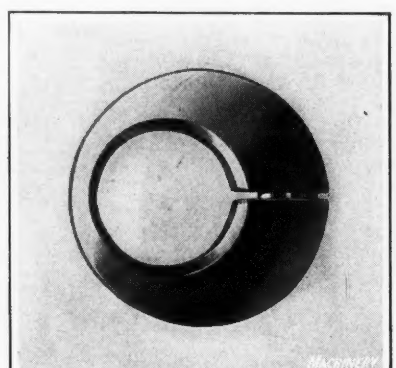
The tool may also be placed in a horizontal position for locating on perpendicular surfaces, and it may be conveniently employed while horizontal or perpendicular in connection with a dividing head for locating holes at an angle. By pressing the lower end of the punch against the work, the sharp point may be used for scribing lines as the work is moved past the tool. This application is especially useful for laying out dies. The punch is hardened and ground all over, and lapped where it is contained in the bearing. The collars on the punch are of equal size and facilitate the alignment of the tool. The holes in the supporting member of this device provide for mounting it on either $\frac{3}{4}$- or $\frac{7}{8}$-inch arbors.



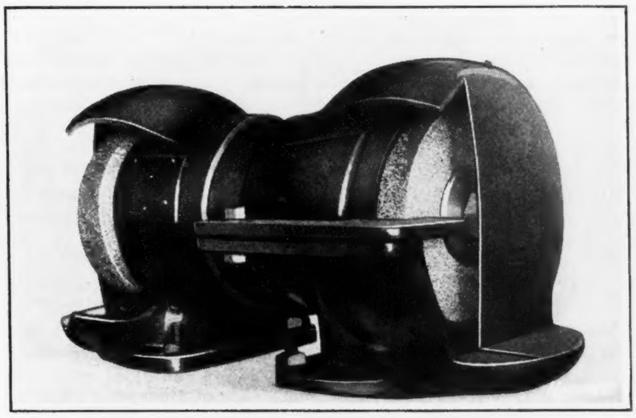
Precision Punch and Scriber manufactured by Bernard F. Johnson

ADJUSTABLE TEMPLET THREAD GAGE

Templet thread gages which are made adjustable by the provision either of one half-way slot leading from the threaded hole or two half-way slots at the periphery, were described in March MACHINERY. These tools are products of the Superior Thread Gage Mfg. Co., Inc., 1985 Troy Ave., Brooklyn, N. Y. Another adjustable ring gage in which the threaded hole is located eccentrically relative to the periphery, in order to obtain the necessary spring for adjustment, is now being made by the same concern. This gage, which is here illustrated, is adjusted in the same manner as the other ring gages referred to, that is, by tightening up a screw placed perpendicular to the split ends of the gage. A hardened drill-rod pin at these split ends keeps the gage from twisting. The outside diameter of gages of this type is considerably less than when half-way slots are provided for obtaining the adjustment. The gage is made in all sizes from 3/16 inch up, for special threads as well as for standard threads.



Thread Gage made by the Superior Thread Gage Mfg. Co., Inc.



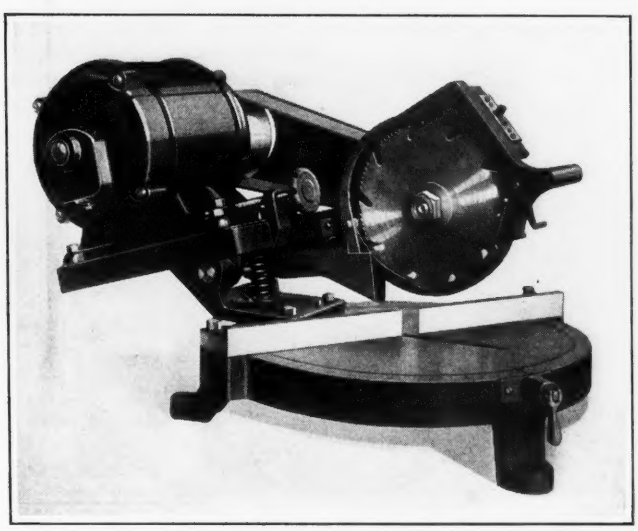
Self-contained Centrifugal-fan Grinder made by Forbes & Myers

FORBES & MYERS GRINDER

The provision of self-contained centrifugal fans for exhausting the dust is the principal new feature of an improved grinder added to the line of products manufactured by Forbes & Myers, 178 Union St., Worcester, Mass. These fans are adjacent to the outside bearings of the grinder spindle and blow the dust directly back through an exhaust pipe. The grinding wheels are located outside of the fans. The motor is of 1/2 or 3/4 horsepower, of the induction type, fully enclosed, and operates on single-, two- or three-phase current. Hess-Bright bearings are used in the construction of this grinder. In the illustration only one wheel is supplied with the tool-rest; however, each wheel may be so equipped or tool-rests may be omitted altogether. While the exhaust action of the fans is effective, they are not intended to take the place of large exhaust systems, for blowing dust through long pipes.

TANNEWITZ PORTABLE SAW BENCH

The accompanying illustration shows a portable wood-cutting saw bench in which the motor and saw are mounted on a frame which swivels 45 degrees each side of a central position. This permits both right- and oblique-angle cuts to be taken. A locking pin engages slots in the periphery of the swiveling member so that the saw can be held at any desired angle. The saw and motor support is pivoted, which enables the saw to be depressed to cut through stock. A coil spring elevates the saw as the operator releases the pressure on the handle used for depressing the saw. The motor is controlled by a simple finger-switch adjacent to this control handle. An adjusting screw provides for varying the tension of the driving belt. This equipment is built by the Tannewitz Works, Grand Rapids, Mich.

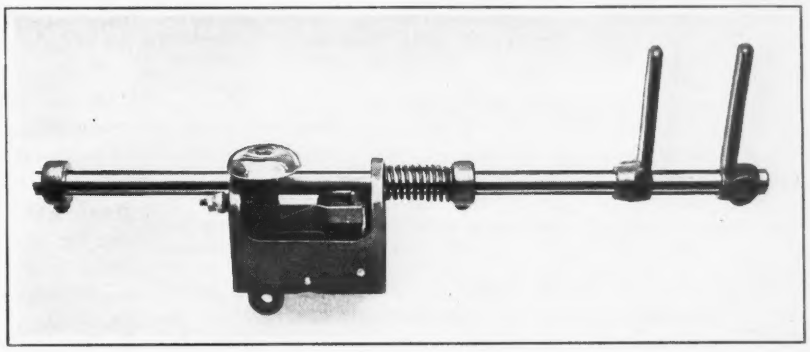


Portable Wood-cutting Saw Bench made by the Tannewitz Works

"SIMPLEX" ELECTRIC SAFETY STOP

Instantaneous operation of a clutch or shifting of a belt on various types of automatic machines in the event that the stock is over-size, under-size, over-fed, or under-fed, or in case some other irregularity occurs, is possible by employing the "Simplex" electric stop. This device is manufactured by the Atlantic Co., 452 Classon Ave., Brooklyn, N. Y., and is intended to be used on a lighting circuit, although it will also function on battery or generator current. Among the various applications of this stop may be mentioned its use on roll-feed blanking presses or four-slide wire formers.

On a blanking press the stop is mounted on the foot-treadle rod, a latch on the stop engaging a notch in this rod. When the stop operates, the latch is disengaged from the notch and the rod is forced forward by the spring. A small spring-lever is also arranged to bear on the blanked scrap as the latter is fed from the die. When the scrap has been fed the desired amount, the lever rests on the metal between the blanked holes, and while thus positioned, the circuit is open. However, if the scrap is over-fed or under-fed, the lever will extend into one of the blanked holes and the circuit will be closed. This will cause the stop to actuate and halt the operation of the machine. In this way injury to a die as a result of punching the metal at a point where it has already been partially blanked out is avoided.



"Simplex" Automatic Safety Stop manufactured by the Atlantic Co.

Wires may be run from the stop to contact points located on a machine wherever trouble is likely to happen. The pressure of the clutch or belt-shifter rod against the stop latch is reduced by means of two unequal levers. A spring for exerting pressure up to 75 pounds may be used in connection with the stop, and such a spring is ample for shifting a 6-inch belt. A hand-trip enables the stop to be operated at any time. The device may be so arranged that it will not interfere with the ordinary method of starting and stopping a machine.

DIAMOND SPROCKET-TOOTH HOBS

On page 592 of March MACHINERY, attention was called to hobs for cutting sprocket teeth to the "American Standard" form. These hobs are not manufactured by the Diamond Chain & Mfg. Co., Indianapolis, Ind., although they were developed by this concern. They are supplied by the Brown & Sharpe Mfg. Co., Providence, R. I., Illinois Tool Works Co., Chicago, Ill., and Union Twist Drill Co., Athol, Mass.

* * *

Reports from Germany indicate that a great development has taken place in recent years in the utilization of compressed air locomotives in mines. In a group of mines at Dortmund, for example, in the year 1919, the number of locomotives in operation was nearly 2300, of which 624 were propelled by compressed air.

NEW MACHINERY AND TOOLS NOTES

Pressed-steel Hanger: Dodge Sales & Engineering Co., Mishawaka, Ind. A pressed-steel lineshaft hanger suitable for use under conditions where excessive vibration is not encountered. The bearing floats in the hanger so as to align itself with the shaft. Set-screws equipped with lock-nuts permit bringing the bearing to the proper height and lateral position.

Bench Lathe: A. V. Carroll Machine Tool Co., Norwood, Cincinnati, Ohio. A bench lathe driven by motor through a countershaft supported by an extension cast on the bed. The swing over the bed is 10 inches, and the distance between centers 24 inches. The carriage is fed by means of a long screw at the front of the machine which is turned by a crank-handle at the right-hand end.

Heavy-lift Portable Crane: Elwell-Parker Electric Co., 4223 St. Clair Ave., Cleveland, Ohio. A heavy-lift portable crane which is similar in general design to a crane brought out by the same concern about a year ago. The new crane has a capacity for lifting loads of 3000 pounds at a six-foot reach and 1000-pound loads at an eight-foot reach. The boom is 12 feet long, but it may be quickly lowered to permit the crane to enter buildings.

Electric Grinder and Buffer: Columbia Mfg. Co., Belleville, Ill. A motor-driven buffer and grinder, which, when used as a grinder, is intended for sharpening tools and performing general light grinding. The motor is of 1/3 horsepower and operates at a speed of 1800 revolutions per minute. The machine is equipped with adjustable tool-rests and guards for the wheels, and wheels 8 inches in diameter, either 1- or 1¼-inches thick, are used. When the machine is employed for buffing purposes, the guards and other fittings are removed.

Metal-parts Washing Machine: Colts Patent Firearms Mfg. Co., Hartford, Conn. An automatic metal-parts washing machine consisting essentially of an endless belt conveyor combined with a washing apparatus. As the work travels on the conveyor it passes through two sets of sprays which operate on both sides and on the top and bottom of the work. The fluid is circulated by means of a pump. All parts which can be handled on racks are put through the machine in that manner, but comparatively large castings may be placed directly on the conveyor.

Automotive-parts Grinding Machine: Cincinnati Grinder Co., Cincinnati, Ohio. A grinding machine particularly designed for operation on crankshaft bearings, valve seats and stems, piston-rings, pins, and push-rods. The machine is made in two styles, one for power feed and the other for hand feed. The power-feed machine provides power traverse and automatic reverse for the table and an automatic in-feed for the grinding wheel. Two back-rests with wooden shoes and two crank-heads are furnished, while adapters provide for holding flanged end cranks.

Portable Power Hacksaw: Edlund Machinery Co., Inc., Cortland, N. Y. A portable power hacksaw for cutting both machine and tool steel. The saw is driven from a small motor, direct-connected through cut gears, current being obtained through an electric light socket. The cutting is done on the back stroke, the saw blade being automatically relieved on the forward stroke to reduce the wear and prolong the life of the blade. The feed is regulated by a weight which can be quickly adjusted to suit the work. When the saw arm is raised to enable work to be put in place, it is automatically held in position until released by the operator. The machine stops automatically when a cut is finished, and can be stopped and started at any time during a cut. Any standard 8-inch blade can be used.

* * *

NEW BOOK ON JIGS AND FIXTURES

JIG AND FIXTURE DESIGN. Edited by Franklin D. Jones. 325 pages, 6 by 9 inches; 297 illustrations. Published by THE INDUSTRIAL PRESS, 140-148 Lafayette St., New York City. Price, $3.

The development of machine tools has been accompanied by a corresponding development of auxiliary equipment for increasing the quantity and improving the quality of the products of these machines. Whenever duplicate parts require some operation such as drilling, planing, or milling, the selection of a suitable type of machine is often followed by the design of whatever special tools or attachments are needed to adapt the machine to the operation required. The tool-guiding and work-holding jigs and fixtures which are now used in practically all machine shops represent the most important class of special equipment, and this book deals exclusively with their design and construction.

As most jigs are used for drilling operations, a book was previously published by MACHINERY entitled "Drilling Practice and Jig Design," covering different types of drilling machines and their use, the design of drill jigs, and, to some extent, the design of fixtures such, for example, as are used on milling machines. While the subjects of drilling and jig design are closely allied, it is no longer possible to cover them both in a single volume, owing to the extensive changes in drilling practice and the increasing use of jigs and fixtures of various types on different classes of machine tools. Therefore, the book referred to has been replaced by two volumes, of which this is one. The other book, "Modern Drilling Practice," is already well known to those interested in the latest types of drilling machines.

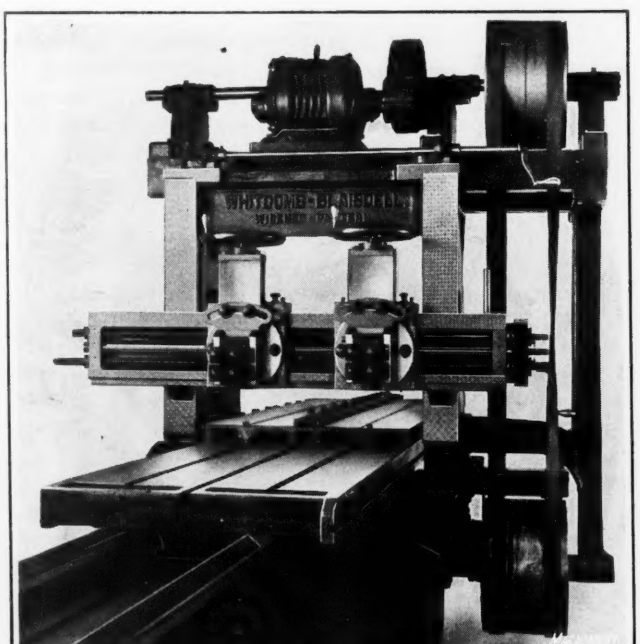
This new book, "Jig and Fixture Design," contains that part of the volume on "Drilling Practice and Jig Design" which dealt with jigs and fixtures. This material was used because it is a treatise on the principles of jig and fixture design which contains information that is indispensable in a book of this kind. These original chapters which explain the general procedure in designing jigs and fixtures and how work should be located, clamped, etc., have been supplemented by a large amount of new matter, thus making the present book a complete treatment of the subject. A great variety of jig and fixture designs have been described and illustrated in order to show just how the principles are applied under many different conditions.

* * *

PLANER OPERATED AT HIGH CUTTING AND RETURN SPEEDS

Brass screen plates are used extensively by paper mills in the manufacture of high-grade paper. In order to machine these screen plates at high rates of production the Whitcomb-Blaisdell Machine Tool Co., 677 Cambridge St., Worcester, Mass., has modified its 26-inch planer to operate at the high cutting and return speeds of 150 feet per minute. The machine is widened to 30 inches so as to permit the holding of work two abreast in a quick-acting fixture. The screen plates are 13 inches wide and 30 inches long. Two standard heads are supplied on the cross-rail, the minimum distance between the heads being 12 inches.

The driving mechanism of the machine is that supplied regularly on the 30-inch planer of this concern. Wider belts, heavier shafts, and larger gears are thus used. Excessive belt speeds and the momentum of the driving pulleys are reduced by increasing the diameter of one pinion and decreasing the diameter of its mating gear so as to lower the ratio. The satisfactory operation of this machine at the higher speeds, however, is mainly attributed to the second-belt drive employed on Whitcomb-Blaisdell planers.



Whitcomb-Blaisdell Planer run at Cutting and Return Speeds of 150 Feet per Minute

MACHINE TOOL MERGER UNCERTAIN

The proposed merger of a number of prominent machine tool manufacturers and one of the well-known dealers in machine tools, for which plans have been under way for several months, had not been effected when this form of MACHINERY went to press (March 27), and we were informed by one of the largest companies affected that there was still considerable uncertainty as to the outcome. The companies included in the list that has been published are: Lodge & Shipley Machine Tool Co., Cincinnati, Ohio; Newton Machine Tool Works, Inc., Philadelphia, Pa.; Hilles & Jones, Wilmington, Del.; Betts Machine Co., Rochester, N. Y.; Colburn Machine Tool Co., Cleveland, Ohio; Modern Tool Co., Erie, Pa.; Carlton Machine Tool Co., Cincinnati, Ohio; and Dale Machinery Co., Inc., New York City and Chicago.

The men who are expected to control the new combination, in case it is effected, are Waldo H. Marshall, formerly president, and C. K. Lassiter, vice-president of the American Locomotive Co.; J. Wallace Carrel, vice-president and general manager of the Lodge & Shipley Machine Tool Co.; Henry J. Bailey, president and general manager of Hilles & Jones; H. W. Champion, president and general manager of the Newton Machine Tool Works; H. W. Breckenridge, general manager and treasurer of the Colburn Machine Tool Co.; J. J. Dale, president, and Robert R. Lassiter, vice-president and secretary, of the Dale Machinery Co., Inc.; A. H. Ingle, president of the Betts Machine Co.; J. C. Carlton, president and general manager of the Carlton Machine Tool Co.

If the new corporation is formed, it will be one of the largest organizations in the machine tool field, manufacturing a comprehensive line for practically all purposes. It will be particularly strong in equipment for locomotive and railroad shops and shipyards.

* * *

GEAR MANUFACTURERS' MEETING

The sixth annual meeting of the American Gear Manufacturers' Association will be held April 20 to 22 at the Lafayette Hotel, Buffalo, N. Y. This association, through a sectional committee, closely cooperates with the American Engineering Standards Committee, and the report of this and other committees on standardization promises to be of unusual interest. Special emphasis will be given to business conditions in the gear industry and the outlook for the immediate future.

Among the subjects to be discussed are "Good Hob Practice," by H. E. Harris of the H. E. Harris Engineering Co., Bridgeport, Conn.; "The Use of the Projector Comparator in Testing Gear Teeth," by Ralph E. Flanders of the Jones & Lamson Machine Co., Springfield, Vt.; "Proportions of Industrial Gears," by G. E. Katzenmeyer, of the R. D. Nuttall Co., Pittsburg, Pa.; "The Grinding of Gear Teeth and its Future in the Industry," by R. S. Drummond, of the Gear Grinding Machine Co., Detroit, Mich.; "The Gleason Works System of Bevel Gears," by F. E. McMullen and T. M. Durkan of the Gleason Works, Rochester, N. Y.; and "Conditions in the Industry," discussed from the standpoint of the member companies under the leadership of George L. Markland, Jr., of the Philadelphia Gear Works, Philadelphia, Pa., and from the automotive standpoint with R. P. Johnson of the Warner Gear Co., Muncie, Ind., presiding. An informal banquet for representatives and guests will be held on Friday evening, April 21, at which the principal speaker will be John C. Bradley of the Pratt & Letchworth Co., Buffalo, N. Y., who will take as his subject "What's Ahead."

* * *

THE POETRY OF THE MACHINE SHOP

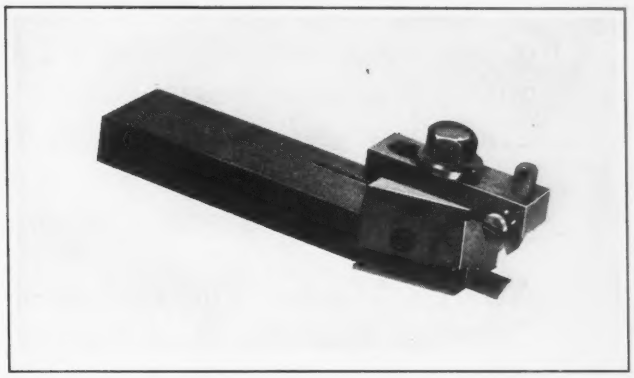
A collection of verse, the subject matter of which relates to science and engineering, is being compiled by Dr. C. E. Ruby, Box 130, Massachusetts Institute of Technology, Cambridge, Mass., who is desirous of obtaining copies or information relating to anything along these lines that has been published.

SCREW MACHINE CUTTING-OFF TOOL

By W. F. HONER

It occasionally happens that the limits on the over-all length of parts intended to be finished on automatic screw machines are much closer than is reasonably expected in the common run of commercial work. Of course, limits as close as plus or minus 0.001 inch can be maintained on such work in the ordinary manner if constant attention is given to the machines, but the improvised tool shown in the accompanying illustration will make the problem of handling this class of work much easier.

This tool was developed from a regular cutting-off toolholder with the cutting-off blade inserted. In making the holder, a hole is first drilled and tapped to receive an ordinary cap-screw, by means of which a suitable tool-holder is clamped to the upper surface of the cutting-off toolholder. The attached holder has a longitudinal slot in it to permit adjustment, and near its extreme outer end a lateral hole is bored to receive the cutting tool, which is held in place by the slotted set-screw. The slotted set-screw permits adjusting the tool so that the part to be operated upon will be cut off to the correct length.



Tool for cutting off Parts to Exact Length

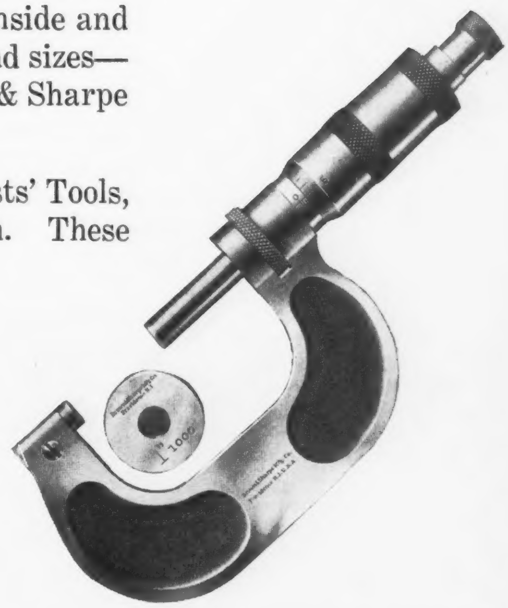
As the cutting-off blade advances to the work, the newly attached facing tool, which is set to give the required over-all length, trims or shaves off the outside face of the piece. No trouble was experienced by the operator of an Acme multiple-spindle automatic screw machine, in keeping the over-all length to within 0.001 inch on all work when this tool was used. The tool has proved very handy and practical.

* * *

OUTPUT OF AUTOMOBILE PLANTS

The seasonal demand is keeping many of the automobile plants well occupied. The March schedule of the Ford Motor Co. called for between 60,000 and 65,000 cars. The new Wills Sainte Claire Co. is said to have increased its output to 20 cars a day, while the Chandler shipments for March are expected to exceed 1000. The General Motors Corporation shipped twice as many cars in January and February as in the corresponding months a year ago. The Dodge plant is reported to be turning out between 2000 and 3000 cars a week, and Buick almost as many, while the Overland plant in Toledo is making between 200 and 300 cars a day. The Chevrolet plants are operating at 100 per cent capacity.

The Studebaker plants in South Bend and Detroit are working at full or nearly full capacity, the production schedule for the first three months of the year calling for 25,000 cars. The Hudson plant is also well occupied. Altogether, the General Motors Corporation is expected to turn out 60,000 cars during the first three months of 1922, compared with 24,000 for the same period last year. The leading automobile companies are unquestionably in a stronger position today than they have been at any time during the last eighteen months, but probably many of the smaller automobile organizations will pass out of existence.



PERSONALS

George J. Keller, formerly sales manager of the Frontier Chuck & Tool Co., Inc., Buffalo, N. Y., has joined the sales force of the Hannifin Mfg. Co., Chicago, Ill.

Ralph M. Sitterley has opened an office at 149 Broadway, New York City, to serve as foreign sales manager of American manufacturers of electrical specialties, marine supplies, automotive products and equipment.

J. Harvey Williams, president of J. H. Williams & Co., Brooklyn, N. Y., manufacturers of drop-forgings and drop-forged tools, has been elected president of the American Drop Forging Institute, and has been re-elected president of the Brooklyn Chamber of Commerce.

Charles B. Wilson, formerly vice-president in charge of operations of the Willys-Overland Co., Toledo, Ohio, has been made general manager of the Willys-Overland and associate companies. The executive offices in New York City are to be closed so that the entire time can be devoted to the Willys-Overland interests in Toledo.

E. M. Griffiths, the founder of Burton, Griffiths & Co., Ltd., of London, England, has resigned his position as managing director and chairman of that company, and has also retired from the board of directors of the Birmingham Small Arms Co., Ltd., so that he is no longer associated with the control of either company. His address is now 30-32 Ludgate Hill, London, E.C., England.

J. T. Slocomb, formerly with the J. T. Slocomb Co., of Providence, R. I., manufacturers of machinists' tools, who sold out his interest in that company and resigned his position as manager a year ago last June, has been devoting much of his time since then to the development of a steam pressure cooker for family use, which is made of monel metal and manufactured by the Economy Cooker Co., Providence, R. I.

Harry Fowler has been appointed district sales manager of the Cincinnati territory of the Carborundum Co., Niagara Falls, N. Y., succeeding Charles R. Cox. Mr. Fowler will take charge of the Cincinnati branch of the company, and will direct the sales force handling carborundum products throughout the Cincinnati district. Mr. Cox will be transferred to the main office at Niagara Falls, where he will take up his new duties on sales statistics.

W. C. Allen, formerly manager of the Philadelphia branch of the Black & Decker Mfg. Co., Towson Heights, Baltimore, Md., and subsequently special representative, has been made branch manager of the Chicago territory of the concern, which includes the states of Wisconsin, Illinois, Missouri, Iowa, Minnesota, and North Dakota. Mr. Allen has been connected with the company for about three years, and previous to that was assistant sales manager of the Manley Mfg. Co.

Julius S. Holl of the Link-Belt Co. was elected president of the Engineering Advertisers' Association at the annual meeting held at the Great Northern Hotel, Chicago, on March 14. The other officers elected at the meeting were as follows: Vice-president, J. B. Patterson, of the P. H. & F. M. Roots Co.; treasurer, C. H. Connell, Weller Mfg. Co.; and secretary, H. N. Baum, Celite Products Co. The members of the board of directors are E. W. Clark of the Clark Equipment Co.; A. K. Birch, Allis-Chalmers Mfg. Co.; Morris W. Lee, of Frank D. Chase, Inc.; and W. F. Leggett of the Chemical Engineering Catalogue Co., Inc.

Henry Harnischfeger and his wife are taking a combined business and pleasure trip around the world. Mr. Harnischfeger is one of the founders and the president of the Pawling & Harnischfeger Co., Milwaukee, Wis., manufacturer of cranes, hoists, monorail systems, horizontal drills, milling machines and all classes of gasoline-driven excavating machinery. They expect to go to Japan, the Philippines, China, Burma, Ceylon, India, and Europe. They will visit the various branch offices of the Associated Machinery Corporation, of which Mr. Harnischfeger is also president, with a view to looking over general business conditions and possibilities in the Far East, and also to determine upon the opening of new offices.

John McConnell has become affiliated with the United Alloy Steel Corporation of Canton, Ohio, in the capacity of vice-president in charge of operation. Mr. McConnell was previously associated with the company, in the early period of its existence, and contributed greatly to its success. He is an alloy steel expert, having been connected for ten years with the Carnegie Steel Co., for three years with the Bethlehem Steel Co. and for eleven years with the United Steel Co. (now the United Alloy Steel Corporation). He was also associated with the Central Steel Co. for one year as consulting metallurgist, and was vice-president in charge of alloy steel production with the Interstate Iron & Steel Co. for three years.

OBITUARIES

Joseph H. Shepherd, formerly mechanical engineer with the Blanchard Machine Co., Cambridge, Mass., died March 2 at his home in Needham Highlands, Mass.

John Lambert, first president of the American Steel & Wire Co., died at Pasadena, Cal., March 6, aged seventy-five years. Mr. Lambert was one of the organizers of the United States Steel Corporation.

Frank E. Cable, one of the organizers of the Porter-Cable Machine Co., Syracuse, N. Y., died in Newton Centre, Mass., on March 7. Mr. Cable was treasurer of this company until about two years ago, when he retired, moving to Nantucket, Mass., and later going to Newton Centre, where he made his home until his death.

Edward M. Barr, manager of the Chicago office of the Chisholm-Moore Mfg. Co., Cleveland, Ohio, died suddenly on March 15. Mr. Barr was born in Milwaukee, and lived there until he went into business about twenty years ago. He was the son of J. M. Barr, one of the pioneer railroad men in the West. His connection with the Chicago office of the Chisholm-Moore Mfg. Co. covered a period of eleven years, and he had a wide acquaintance among the trade in that district. His untimely death comes as a great shock, and his loss will be keenly felt by all those who knew him. He leaves a wife and one son.

James E. Greensmith, president of the Boston Scale & Machine Co. of Boston, Mass., died on March 8. He was born in Burton-on-Trent, England, where he was educated as a mechanical engineer. His early business experience was obtained in India, and he later came to this country to take charge of the Pond Machine Tool Co., which at that time was constructing a new factory in Plainfield, N. J. Mr. Greensmith supervised the construction and equipment of the plant, as well as the design and development of a new type of heavy gun turning and boring lathe which was later installed in the Watervliet Arsenal. Upon leaving the employ of the Pond Machine Tool Co. he became associated with the Portland Co. of Portland, Me., as superintendent, and later became superintendent of the Mason Machine Works, Taunton, Mass., which position he held for many years. For the last six years he has been president and general manager of the Boston Scale & Machine Co., manufacturer of electric weighing and recording scales, rotary grinders and special machinery. He was a member of the American Society of Mechanical Engineers and also of the Engineers Club of Boston.

* * *

WARNING AGAINST IMPOSTOR

The National Machine Tool Builders' Association has distributed the following letter throughout the machine tool industry in order to protect it from similar fraud. A New England member of the association wrote as follows:

On February 8, we were visited by a man who presented a card bearing the following inscription:

Member A. S. M. E.
Plant Engineer R. C. Cannon, M. E.
Pawling & Harnischfeger Co. Milwaukee, Wis.

As we have had business in the past with the above company, the bearer of the card was duly received as an accredited representative of Pawling & Harnischfeger. He claimed to be interested in behalf of his company in investigating other of our machines, and spent the entire day with us.

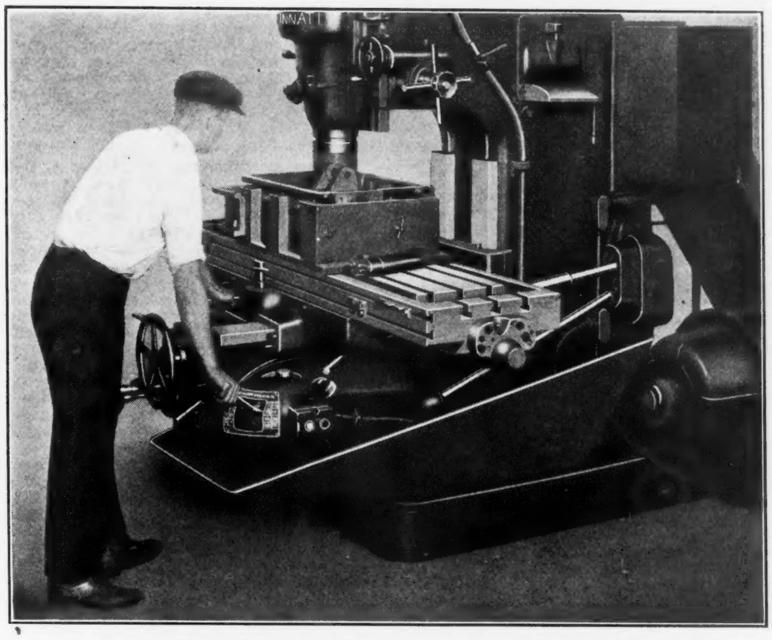
On his arrival, he informed us he had left a package of blueprints he had brought for our consideration on the train and in addition a wallet containing the most of his money, also important papers. He had, however, a certified check drawn on the West Allis Bank, West Allis, Wis., which we agreed to cash for him.

After his departure and at his request, we forwarded in his name to Pawling & Harnischfeger Co., circulars and other data relating to the matters he discussed with us. We have just received a letter from Pawling & Harnischfeger acknowledging receipt of the circulars and our letter addressed to R. C. Cannon, care of Pawling & Harnischfeger, from which it is evident that the man is an impostor. In addition, the certified check which we cashed is declared a forgery by the West Allis Bank and returned to us through our bank.

We thought it advisable to inform you at once regarding this matter, as you might, under the circumstances, wish to take some action in regard to placing other members on their guard against this party.

The same fraud has been heard of in Cincinnati, and members of the machine tool industry throughout the country should take warning.

PUT YOURSELF IN HIS PLACE! Wouldn't *you* be willing to hasten this job by changing the table direction 20 times—if you could do it by *merely moving a lever?*



The No. 4 Cincinnati Vertical

The operator's hands are on the table quick traverse lever and the feed change lever. He uses the other two levers for cross and vertical feeds.

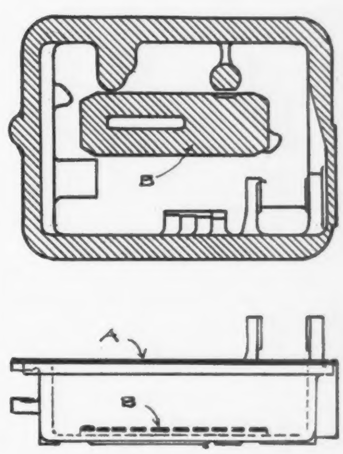
The operator on the No. 4 Cincinnati Vertical doesn't *have* to make all these changes. He *can* do the work with much less.

But he *does* make them because it is easy. He merely moves a lever. He doesn't change his position.

It requires very little effort and he saves time. Therefore he does it because it means more money for him. And for you it means greater production. He uses the table quick traverse (100 in. per minute) 3 times and changes feed 3 times, with the same ease and for the same reason.

Are you missing all this by using old-fashioned Millers?

Tell us about your work and we will show what you can save.



The width of the flange varies and there are bosses. Time is saved by using a small mill and changing direction many times, because it is easy to change direction.

The Cincinnati Milling Machine Co.

CINCINNATI, OHIO, U. S. A.

COMING EVENTS

April 7—Meeting of the New York Section of the American Society of Mechanical Inspectors at 29 W. 39th St., New York City. Secretary, H. M. Spitzenberg, 29 W. 39th St., New York City.

April 19-20—Annual meeting of the National Metal Trades Association in New York City; headquarters, Hotel Astor. Secretary, Homer D. Sayre, Peoples' Gas Bldg., Chicago, Ill.

April 20-22—Sixth annual convention of the American Gear Manufacturers' Association in Buffalo, N. Y.; headquarters, Lafayette Hotel. Secretary, F. D. Hamlin, 4401 Germantown Ave., Philadelphia, Pa.

April 21—Joint meeting of the Metropolitan Section of the Society of Automotive Engineers with the New England Section in New Haven, Conn. Secretary, C. F. Clarkson, 29 W. 39th St., New York City.

April 22-May 2—Sixth annual Swiss sample fair at Basle, Switzerland, in the Great Exhibition Bldg. For further information apply to F. Dossenbach, Director of the Official Information Bureau of Switzerland, 241 Fifth Ave., New York City.

April 24-26—Joint meeting of the American Supply and Machinery Manufacturers' Association and the Southern Supply and Machinery Dealers' Association at Birmingham, Ala.; headquarters, Tutweiler Hotel. Secretary, American Supply & Machinery Manufacturers' Association, F. D. Mitchell, 4106 Woolworth Bldg., New York City.

April 25-26—Spring convention of the National Machine Tool Builders' Association in Atlantic City, N. J.; headquarters, Hotel Traymore. General Manager, E. F. DuBrul, 817 Provident Bank Bldg., Cincinnati, Ohio.

April 26-28—Spring convention of the Society of Industrial Engineers in Detroit, Mich.; headquarters, Hotel Statler. Business Manager, George C. Dent, 327 S. La Salle St., Chicago, Ill.

May 8-10—Annual convention of the National Supply & Machinery Dealers' Association in Atlantic City, N. J.; headquarters, Marlborough-Blenheim Hotel. Secretary, Thomas A. Fernley, 505 Arch St., Philadelphia, Pa.

May 8-10—Twenty-seventh annual convention of the National Association of Manufacturers in New York City; headquarters, Waldorf-Astoria Hotel. General offices of the association, 50 Church St., New York City.

May 8-11—Spring meeting of the American Society of Mechanical Engineers in Atlanta, Ga. Assistant Secretary (Meetings), C. E. Davies, 29 W. 39th St., New York City.

May 10-12—Ninth National Foreign Trade Convention in Philadelphia, Pa. Secretary, O. K. Davis, 1 Hanover Square, New York City.

May 18-20—Annual conference of the National Association of Office Managers in Washington, D. C. Secretary, F. L. Rowland, Gilbert & Barker Mfg. Co., Springfield, Mass. Guests are invited to attend.

June 5-9—Annual convention and exhibit of the American Foundrymen's Association and allied societies in Rochester, N. Y. Secretary, C. E. Hoyt, Marquette Bldg., 140 S. Dearborn St., Chicago, Ill.

June 14-21—Annual meeting of the Mechanical Division of the American Railway Association in Atlantic City, N. J. Secretary, V. R. Hawthorne, 431 S. Dearborn St., Chicago, Ill.

June 15-24—International exhibition of foundry equipment and materials in Birmingham, England, in connection with the annual convention of the Institution of British Foundrymen.

June 20-24—Summer meeting of the Society of Automotive Engineers at White Sulphur Springs, W. Va. Chairman of Meetings Committee, C. F. Scott, 29 W. 39th St., New York City.

June 26-July 1—Twenty-fifth annual meeting of the American Society for Testing Materials in Atlantic City, N. J.; headquarters, Chalfonte-Haddon Hall Hotel. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

August 28-September 2—Annual Safety Congress of the National Safety Council in Detroit, Mich. Secretary, S. J. Williams, 168 N. Michigan Ave., Chicago, Ill.

The sectional meetings of the American Society of Mechanical Engineers for April are as follows: April 1—Oregon Section at the Oregon State Agricultural College, Corvallis, Ore. April 3—Syracuse Section at the Onondaga Hotel, Syracuse, N. Y. April 4—Eastern New York Section at Edison Hall, Schenectady, N. Y.

SOCIETIES, SCHOOLS AND COLLEGES

Melbourne Technical School, Melbourne, Australia. Prospectus of the Workingmen's College of the school for the year 1922, covering courses of study, tuition, and other related matters.

NEW BOOKS AND PAMPHLETS

Iowa Women in Industry. 73 pages, 6 by 9 inches. Published by the United States Department of Labor, Washington, D. C., as Bulletin No. 19 of the Women's Bureau.

Perpetual Inventory or Stores Control. 30 pages, 6 by 9 inches. Published by the Fabricated Production Department of the Chamber of Commerce of the United States, Mills Bldg., Washington, D. C.

The Production of Liquid Air on a Laboratory Scale. By J. W. Cook. 10 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Scientific Paper No. 419 of the Bureau of Standards. Price, 5 cents.

Method for Precision Test of Large-capacity Scales. By C. A. Briggs and E. D. Gordon. 16 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Technologic Paper No. 199 of the Bureau of Standards. Price, 5 cents.

Thermal Expansion of Nickel, Monel Metal, Stellite, Stainless Steel, and Aluminum. By Wilmer H. Souder and Peter Hidnert. 23 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Scientific Paper No. 426 of the Bureau of Standards. Price, 10 cents.

Effect of Heat-treatment on the Mechanical Properties of One Per Cent Carbon Steel. By H. J. French and W. George Johnson. 121 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Technologic Paper No. 206 of the Bureau of Standards. Price, 15 cents.

Weights and Measures. 132 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Miscellaneous Publication No. 48 of the Bureau of Standards. Price, 20 cents.

This pamphlet contains a report of the fourteenth annual conference on weights and measures of representatives from various states held at the Bureau of Standards in Washington, May 23 to 26, 1921.

Manual for Engineers. Compiled by Charles E. Ferris, Professor of Mechanical Engineering, University of Tennessee. 230 pages, 2¾ by 5¾ inches. Published by the University of Tennessee, Knoxville, Tenn. Price, 75 cents.

This little vest-pocket handbook for engineers and business men has reached its twenty-fourth edition. It contains about fifty tables considered to be of the greatest general use, including tables of areas and circumferences of circles; squares, cubes, square roots and cube roots; logarithms; sines, tangents, and secants; decimal conversion tables; weights of square and round bars; earthwork tables; wiring tables; interest tables, etc. The small size of this book makes it convenient to carry about for constant reference, but it has the disadvantage of making it necessary to use such small type that the figures in some cases are not very clear.

Mechanical World Electrical Pocket Book. 393 pages, 5 by 6¼ inches. Published by Emmott & Co., 65 King St., Manchester, England. Price, 2 s., net.

The 1922 edition of this little reference book has been enlarged considerably, and its scope has been extended to include a section on power station construction and operation. This contains considerable information of interest to those concerned with electric generating equipment. Another new section dealing with electric hoists contains much information on the construction and installation of such equipment. For the benefit of those not familiar with this book it may be stated that it represents a collection of electrical engineering notes and rules, as well as considerable tabular material, covering dynamos and motors, transmission conductors and cables, wiring systems and methods, lighting circuits and switching, electrical measurements and testing, electric lamps, telephones, small electric tools, electric welding, electric heating and cooking, etc.

Milling Cutters and Milling. 69 pages, 5 by 7½ inches. Published by the National Twist Drill & Tool Co., Detroit, Mich. Price, $1.

The purpose of this book is to present to those interested in the art of milling, data gathered by this company during a long period of intimate contact with milling work in its various branches, together with the results of extensive research work carried on at the University of Michigan within the last two years. The material should be of benefit to makers and users of milling cutters alike. The book contains fifteen chapters under the following headings: The Process of Milling; Milling Compared with Turning and Planing; Research Equipment; Rake; Clearance and Spiral; Shape of Teeth; Chip Space; Number of Teeth; Cutter Design and its Effect on Power Requirements; Feeds; Cutter Speeds; Lubrication and Cooling; the Milling Machine; its Relation to the Cutter; the Care of Milling Cutters; and Various Types of Milling Cutters and their Uses.

Burning Liquid Fuel. By William N. Best. 341 pages, 6 by 9 inches. Published by the U. P. C. Book Co., Inc., 243 W. 39th St., New York City. Price, $5, net.

It is generally recognized that the burning of liquid fuel is a science and that successful results can be obtained only by burning it scientifically. The information contained in this book is based on a study of over 42,000 burner installations, and the results should eliminate guesswork, and enable power plant owners to reduce their power costs considerably. The book gives comparative fuel costs, installation methods, ways of burning liquid fuel economically, and presents the results of a great number of tests and installations. The subject matter covers all forms of equipment for burning liquid fuels, giving information on the design and proper installation in each case. The equipment used in foundry practice, heat-treating furnace practice, forge-shop practice, and many diversified fields, is dealt with. Simple language is used so that the book will be readily understood by all.

Mechanical World Year Book. 348 pages, 4 by 6¼ inches. Published by Emmott & Co., Ltd., 65 King St., Manchester, England. Price 2s. 6d., net.

This well-known reference book is now in its thirty-fifth edition, and has been enlarged by the addition of twenty pages. The section on boiler construction has been largely rewritten, and a considerable amount of new matter has been added. A new section on pipes and tubes contains a concise collection of data on pipes of cast iron, wrought iron, steel, and copper, with many tables of dimensions, and particulars of flanged bends and tees, expansion bends, etc. The tables on the thermal properties of solids, liquids, and gases which appeared in a former issue have been restored by request, as have also the tables of weights of hexagonal and octagonal bars. A table giving the weights of fillets is also included. Many other sections of the book have been revised, and a number of new illustrations have been introduced. One of the valuable regular features of the book is the classified buyers' directory which is published in four languages—English, French, Russian, and Spanish.

Jigs and Fixtures. By Albert A. Dowd and Frank W. Curtis. 293 pages, 6 by 9 inches; 232 illustrations. Published by the McGraw-Hill Book Co., Inc., New York City. Price, $3.

This is the first of a series of three books covering the subject of tool engineering. This volume deals with the design of jigs and fixtures. It covers the important points connected with the design, compares different methods, and takes up principles of design and their application. A large number of diagrams are included to illustrate the principles involved. In this book the aim has been to deal chiefly with fundamental principles, rather than with specific designs, so that the designer can analyze his own peculiar problems and apply the principles set forth to the case under consideration. The subject matter is divided into eleven chapters under the following headings: Outline of Tool Engineering; Fundamental Points in Drill Jig Design; Details of Drill Jig Construction; Open and Closed Jigs; Indexing and Trunnion Jigs; Details of Milling Fixture Construction; Design of Milling Fixtures; Design of Profiling Fixtures; Vise Jaws and Vise Fixtures; Broaches and Broaching Fixtures; and Design of Riveting Fixtures.

Electric Arc Welding. By E. Wanamaker and H. R. Pennington. 254 pages, 6 by 9 inches. Published by the Simmons-Boardman Publishing Co., Woolworth Bldg., New York City. Price, $4.

The authors of this work have not attempted to cover the electric welding art in its broadest sense, but have confined the treatment exclusively to autogenous electric arc welding. The phenomena of the welding arc and the metallurgy of welding are in such a state of development that the authors' information has been limited to the research which has come under their observation. The effort has been made to present information that is most in demand for practical purposes. The material is conveniently arranged for ready reference. The book treats of many phases of the application of the art and covers descriptions of welding systems and their installation, phenomena of the metallic and carbon welding arc, training of operators, sequence of metal disposition for various types of joints and building up operations, electrode materials used, weldability of various metals, weld composition, thermal disturbances of parts affected by the welding process, physical properties of completed welds, efficiency of welding equipments expressed in pounds of metal used or deposited per kilowatt hour, welding cost, etc.

Materials of Construction. By the late Adelbert P. Mills. Second edition, edited by Harrison W. Hayward, Professor of Materials of Engineering, Massachusetts Institute of Technology. 476 pages, 6 by 9 inches. Published by John Wiley & Sons, Inc., 432 Fourth Ave., New York City. Price, $4.

This is the second edition of an original work prepared by the late Professor Mills of Cornell University. No attempt has been made to change the original fundamentally, but in the new edition certain chapters have been condensed, parts of others have been rewritten, and several new chapters have been added. The book has also been divided into sections. The original work was prepared to meet the need for a general textbook covering the manufacture, properties, and uses of the more common materials of engineering construction. The treatment of the various classes of materials considered follows a general systematic form which has been made uniform throughout as far as practicable. The consideration of each material or class of materials is prefaced by a discussion of its ordinary applications in engineering construction, followed by a study of its manufacture or natural occurrence, and concluded by a discussion of physical and mechanical properties in their relation to its uses. Whenever possible the data has been presented

graphically by curves or diagrams. The materials covered are as follows: Plaster, lime, natural cement; Portland cement and concrete; stone; bricks and other clay products; ferrous metals; non-ferrous metals and alloys; timber; rope; and mechanical fabrics.

NEW CATALOGUES AND CIRCULARS

Electric Controller & Mfg. Co., Cleveland, Ohio. Bulletin 1031-A, descriptive of E. C. & M., Type DR drum controllers for direct-current and alternating-current motors.

H. Gerstner & Sons, 53-63 Columbia St., Dayton, Ohio. Catalogue 22, containing specifications for the different sizes and styles of tool cases and chests made by this concern.

Kales Stamping Co., 1659 W. Lafayette Blvd., Detroit, Mich. Circular containing a list of sizes of special washers, of any gage or any material, for which the company has dies.

Wagner Electric Mfg. Co., St. Louis, Mo. Circulars outlining the main features of the Wagner "Pow-R-full" polyphase motor. Attention is called especially to the rigidity of construction.

New Departure Mfg. Co., Bristol, Conn. Looseleaf sheets 143 FE and 144 FE, illustrating the application of New Departure single- and double-row ball bearings in metal spraying pistols and in mixing machine heads.

Deschanel Engineering Corporation, 90 West St., New York City. Bulletin descriptive of the Deschanel single-line cableway for handling coal and other materials, when unloading from railroad cars or barges into storage.

Surface Combustion Co., 362 Gerard Ave., Bronx, New York City, announces that it now has ready for distribution Bulletin 3D on Surface Combustion low-pressure air-gas inspirators, which are so designed that they may be readily applied to any make of gas furnace.

John Steptoe Co., Cincinnati, Ohio. Catalogue covering the Steptoe line of shapers, milling machines, and engine lathes. Specifications are given for the 14-, 16-, 20-, and 24-inch crank shapers, the No. 0 hand and power feed milling machines, and the 14-, 16-, 18-, and 20-inch lathes.

Technical Advisory Corporation, 132 Nassau St., New York City. Pamphlet outlining the activities of the concern, which cover service to manufacturers, bankers, and public utilities, research and development work, appraisals, the development of foreign trade, and industrial surveys.

Hamblin Tool Mfg. Co., Inc., 42 Mechanic St., Newark, N. J. Circular entitled "The Wrench that Grips and Never Slips," illustrating the use of the Hamblin reversible chain pipe wrench, which has a cam action permitting it to be reversed instantly without detaching the chain.

Black & Decker Mfg. Co., Towson Heights, Baltimore, Md. Miniature catalogue containing illustrations, specifications, and prices of Black & Decker portable electric drills, electric screwdrivers and socket wrenches, electric grinders, safety cleaning machines, and electric valve grinders.

Oliver Machinery Co., Grand Rapids, Mich. Bulletin 5, containing information on the care of circular sawing machines of the type used in woodworking plants and pattern shops. The catalogue illustrates a number of different styles and sizes of these machines. Copies will be sent to those interested upon request.

Whiting Corporation, Harvey, Ill. Circular illustrating the equipment made by this concern, which includes cranes, foundry equipment, trolley systems, hoists, transfer tables, etc. This company is also issuing to the trade a desk calendar card covering the last three months of 1921, the year 1922, and the first three months of 1923.

Foxboro Co., Inc., Foxboro, Mass. Pamphlet entitled "How Far Can You Read It?" devoted to Foxboro dial type thermometers, which are designed to give a maximum degree of visibility, the indicator having a dull black ground and white figures. These thermometers are made entirely of metal, there being no glass tubes to break.

Air Reduction Sales Co., 342 Madison Ave., New York City. Leaflet descriptive of the "Airco" D cutting torch, covering the features of design and construction, and containing tables showing the thicknesses of metals that can be cut, pressures of oxygen and acetylene necessary, and the gas consumption in cubic feet per hour when using tips adapted to the cutting of steel, cast iron, or rivets.

Wodack Electric Tool Corporation, 23-27 S. Jefferson St., Chicago, Ill. Bulletin 908, describing the Wodack combination portable electric drill and grinder, which is designed to fill the needs of shops and factories where drilling and grinding operations are performed but where there is not enough work of this kind to warrant the purchase of two separate machines. Complete specifications are given, including price.

Madison Mfg. Co., Spring and Elton Sts., Muskegon, Mich. Circular illustrating and describing Madison adjustable boring heads for rough- or finish-boring, made in sizes from 2¼ to 8 inches in diameter; adjustable boring cutters and bars for finish-boring; and counterbores equipped with cutters that are made to work both ways, so they can be used for front or back facing. In addition to the general description, complete price lists are given for the various sizes.

Ingersoll Milling Machine Co., Rockford, Ill. Circular illustrating Ingersoll milling machines, equipped with Ingersoll fixtures and cutters, for use in railway shop work and ordinary production work. The fixtures are shown applied to continuous rotary milling machines, heavy-duty adjustable-rail milling machines, fixed-rail reciprocating machines, horizontal-spindle milling machines, drum-type continuous milling machines, reciprocating continuous milling machines and multiple-spindle fixed-rail milling machines.

American Machine Products Co., Detroit, Mich. Circular illustrating "Ampco" Critchley improved adjustable reamers and Simplex gages for adjusting these reamers to the correct size for reaming the different sizes of bushings in Ford automobiles. In applying the gages, it is merely necessary to select a gage of the same size as the bushing to be reamed, place the reamer in a vise, and put the ring, or gage, over the reamer, after which the blades are adjusted until the ring is a snug fit on the tool. The adjustment by this method is said to require only five minutes, as compared with thirty minutes when adjusting with a micrometer. The reamers and gages are supplied in sets of different sizes. They are marked with corresponding letters, so that the gage to use with a reamer for a certain size bushing can be readily determined. The circular gives full particulars, including dimensions, prices, etc., for the sets, as well as for single tools.

TRADE NOTES

Gropler Bros., representatives of manufacturers of metal-cutting tools, are now located at 16-22 Hudson St., New York City.

Monarch Machine Tool Co., 209 Oak St., Sidney, Ohio, announces that it has made a reduction of 10 per cent in the price of Monarch lathes.

G. A. Ball Bearing Mfg. Co. has moved into a new factory at 3305-3335 W. Harrison St., Chicago, Ill. The building is of one-story, saw tooth construction.

Taft-Peirce Mfg. Co., Woonsocket, R. I., has moved its Detroit office from 1311 Majestic Bldg. to 2230 First National Bank Bldg. William Fairhurst is manager of the Detroit office.

Toledo Tap & Die Co., Toledo, Ohio, manufacturer of taps and dies, announces that it has opened a Cleveland office at 716 Superior Ave., N. W., and a Pittsburg office at 631 Fulton Bldg.

Chicago Flexible Shaft Co., 1154 S. Central Ave., Chicago, Ill., has moved its St. Louis office, which handles the sale of Stewart industrial furnaces, from the Railway Exchange Bldg. to 420 Wainwright Bldg.

Seneca Falls Mfg. Co., Inc., Seneca Falls, N. Y., at its annual meeting of stockholders in February re-elected Ogden R. Adams, president and general manager of the company. An entirely new board of directors was also elected.

Black & Decker Mfg. Co., Towson Heights, Baltimore, Md., has moved its Cleveland office from 6225 Carnegie Ave., to 2030 E. 22nd St. This office is in charge of Dan Paul, former manager of the Pittsburg office of the company.

Massachusetts Gear & Tool Co., 30 Nashua St., Woburn, Mass., has purchased the business of the Woburn Gear Works. The company will specialize in accurately cut small and medium size gears and sprockets of all types and of all materials.

Russell Mfg. Co., Greenfield, Mass., has appointed the **A. Z. Boyd Co.**, 126 Chambers St., New York City, as the New York agent for the sale of the Russell line of screw plates. The A. Z. Boyd Co. has had wide experience in the past in selling tools of this kind.

Tool Sales Co. announces that it is now located in the Hudson-Reade Building, New York City. This company sells tools and specialties to the hardware and automobile supply trade, and is in a position to render sales service in the Metropolitan District to manufacturers who are in need of such services.

Williams, White & Co., Moline, Ill., have taken over the Osterholm automatic surface grinding machine formerly made by the Osterholm Automatic Machine Co. of Chicago. In the future this machine will be manufactured in the Williams, White & Co.'s plant in Moline. This machine was described in the technical press about six months ago.

Colonial Steel Co., Pittsburg, Pa., has purchased a lot in Cleveland, Ohio, at 2121 St. Clair Ave., and is now having plans drawn and will begin at once the erection of a brick warehouse to be used for the storage and sale of Colonial steel. This warehouse will also be equipped with furnaces for heat-treating steel with a view to assisting customers in working out problems of this kind.

Eastern Machine Screw Corporation, 23-43 Barclay St., New Haven, Conn., manufacturer of H & G automatic die-heads, collapsible taps, and screw machine products, announces that its die-head works are now operating five days a week and ten hours a day. The business of the company has shown a decided improvement during the months of January and February.

Diamant Tool & Mfg. Co., Inc., 95 Runyon St., Newark, N. J., has appointed the **McMullen Machinery Co.**, 64-66 Ionia Ave., Grand Rapids, Mich., its exclusive representative in connection with the sale of Diamant standard punch and die sets in the territory covered by the northern and the southern peninsulas of Michigan, west of the counties of Bay, Saginaw, Shiawassee, Ingham, Jackson, and Hillsdale.

Shepard Electric Crane & Hoist Co., Montour Falls, N. Y., announces that its New York and Philadelphia territories have been consolidated under the management of Mr. Gledhill, with headquarters at the New York office, 30 Church St. Although the Philadelphia office has been closed, the number of sales engineers in that territory, as well as in the New York territory, has been increased so that closer personal contact can be maintained with concerns in these sections.

Kendell Engineering Co., 12 North American Bldg., Fort Wayne, Ind., manufacturer of Kendell piston-rings, announces that it has made definite plans for expansion, having incorporated under the state laws of Indiana and now being known as the **Kendell Engineering Corporation.** The construction of a new plant is to begin at once. The officers of the company remain the same as before, namely, C. A. Kendell, president; Robert L. Kendell, vice-president and sales director; and M. W. Cartwright, secretary and treasurer.

C. H. Wood Co., 214 W. Jefferson St., Syracuse N. Y., wholesale dealer in machinery, tools, factory supplies and equipment, has changed ownership, the interest of Charles H. Wood having been purchased by Wilton R. Olds, George E. Ingraham and A. J. Littlejohn. Mr. Olds has been elected president and general manager of the company; Mr. Littlejohn, vice-president; and Mr. Ingraham, secretary and treasurer. Mr. Littlejohn is also secretary of the Meldrum-Gabrielson Corporation, and will continue his activities with that firm.

Medart Patent Pulley Co., St. Louis, Mo., manufacturer of power transmission machinery, has changed its name to the **Medart Co.** The change was made because of the fact that the former name gave an erroneous idea of the extent of the line carried by the company, which includes, besides cast-iron and wood-pulleys, friction clutches, rope drives, gears, sprockets, hangers and bearings of all kinds, turned and polished steel shafting, as well as machines for turning, polishing, and straightening shafting, and other special machinery and equipment.

Air Reduction Sales Co., 342 Madison Ave., New York City, and the Davis-Bournonville Co., Jersey City, N. J., have been amalgamated. The arrangement will make the combined sales and service facilities of both companies available to users of oxy-acetylene equipment. The firm will continue to make the "Airco" products, which include oxygen, acetylene, welding and cutting apparatus and supplies, acetylene generators, carbide, nitrogen, and argon, as well as the Davis-Bournonville welding and cutting apparatus, including the oxygraph, radiagraph, tube-welding equipment and other special devices.

Greenfield Tap & Die Corporation, Greenfield, Mass., has compiled a comprehensive telegraph and cable code for the benefit of its customers. The code was originally intended for overseas customers, but it is equally suitable for domestic concerns, and will enable cable and telegraph expense to be materially reduced. The technical nature of the company's products, which include screw plates, taps and dies, drills, reamers, gages, and machine tools makes it difficult to describe them by any standard code, and the five-letter code compiled by the company enables these products to be ordered by wire at the minimum of expense. The code is included in the new 46-A catalogue which has just been issued by the company. Copies will be sent upon request.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has made a number of changes in personnel. The new appointments are as follows: R. L. Rathbone, branch manager of the Cleveland office, will take up special duties in connection with merchandising matters, with headquarters in Cleveland; J. Andrews, Jr., manager of the industrial division of the Pittsburg office, has been appointed manager of the Cleveland office, and will be succeeded by C. D. Taylor in the Pittsburg office; W. R. Keagy has been appointed office manager of the Cincinnati office; J. R. Deering has been made office manager of the Los Angeles office; and R. Seybold has been appointed manager of price statistics, and will also act as secretary of the domestic sales committee.

Whiting Corporation, Harvey, Ill., manufacturer of electric traveling cranes and foundry equipment, has established a branch sales office in New York City at 136 Liberty St., having discontinued its agency agreement with the Wonham, Bates & Goode Trading Corporation, who formerly represented the company in the East. J. Ross Bates, one of the vice-presidents of the Whiting Corporation, is in charge of the new office. He will be assisted in the New York territory by D. Polderman, Jr., and in the New England states by R. C. Maley, who will open an office at Springfield, Mass. A branch office has also been opened in Indianapolis, Ind., at 305 Merchants Bank Bldg., in charge of S. E. Stout, who was formerly located at the main office in Harvey. Mr. Stout will cover southern Indiana and adjoining cities in Ohio and Kentucky. The Detroit office of the company has been moved from Penobscot Bldg. to 206 Stahelin Bldg., 3000 Grand River Ave.